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The Travel Cost Approach for Valuing Improved Water Quality: Additional Considerations

Draft Report

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PREFACE

This research project was initiated and supported under Contract No. 68-01-6596, Subcontract 700-C, by the Benefits Staff in the Office of Policy Analysis at the U.S. Environmental Protection Agency.

This draft report integrates the research findings from the two complementary work assignments. In its final form it will be the final deliverable for Work Assignment 7 and will partially fulfill the deliverables in Work Assignment 1.

This report extends the research on the travel cost approach previously reported in A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvement. It extends that work by considering the role of recreation activities in the generalized travel cost model, developing a new estimator consistent with the limited dependent variable, and reporting several alternative measures of changes in consumer welfare. While the present report is a standalone volume, the reader is referred to the previous report for some of the detailed discussion on the travel cost approach.

The constructive comments and extraordinary patience over the course of this work of our two EPA project officers, Drs. Ann Fisher and Reed Johnson, are greatly appreciated. This draft will be revised to reflect their comments and those of other reviewers.

In many ways this report is a joint effort beyond that of the primary authors.

Matthew McGivney conducted extensive correspondence with the managers of the various sites and is largely responsible for Chapter 4. Carol Gilbert, formerly of the University of North Carolina at Chapel Hill and presently with General Motors Corporation, prepared most of the analysis in Chapter 5. Clive Woodward and Dennis Schroeder of Vanderbilt University provided valuable assistance in the research. Finally, we have benefited from the editorial assistance of Kathleen Mohar and John Morey. We also appreciate the production scrutiny of Hall Ashmore and Jan Shirley and the excellent support of RTI's Word Processing Center.

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CHAPTER 1

INTRODUCTION, OBJECTIVES, AND SUMMARY

1.1 INTRODUCTION

This report to the U.S. Environmental Protection Agency (EPA) presents the “second generation” of a generalized travel cost model originally developed by Desvousges, Smith, and McGivney [1983] as part of a comparison of alternative approaches for estimating the recreation benefits of water quality improvements. This research extends the earlier model by evaluating the effects of using different samples of recreation sites, a wider range of model specifications, and two different statistical estimation approaches. These effects are evaluated by using the amended travel cost model to predict the benefits of water quality improvements for 21 recreation sites.

In addition to reporting the results for the amended model, this report considers seven issues that arise in using the generalized travel cost model to estimate the recreation benefits of water quality improvements:

- Can the generalized travel cost model be amended to provide a consistent theoretical basis for evaluating the influence of a diverse mix of recreational activities?
- Are existing data sources adequate for the amended travel cost model?
- How representative is the site and user sample employed in estimating the model?
- How sensitive are the estimated benefits of improved water quality to the statistical techniques used to estimate the generalized travel cost model?
- Does the conceptual definition of the benefit measure (i.e., Marshallian or Hicksian) and the specific practices used to implement them affect the estimated benefits of water quality improvements?

- How comparable are the benefits estimated with the generalized cost model to those for other studies?
- What are the implications of the study findings on the recreation benefits of water quality improvements for public policy evaluations?

These questions, and their answers, are relevant to several issues involving the programs that regulate water quality. The travel cost framework is one of the most widely used approaches for estimating recreation benefits. For example, the Water Resources Council recommends it for estimating the recreation benefits associated with changes in the character or quality of recreation sites. Moreover, it is one of the principal benefit estimation methods identified in EPA's guidance for responding to Executive Order 12291, which requires regulatory impact analyses and, hence, benefits estimation for major regulations that have an annual impact of $100 million or more on the economy. With the Clean Water Act of 1978 undergoing Congressional review, and with new regulatory initiatives already underway to assess environmental damages at Superfund sites, there is a clear need for the additional understanding of a key approach to estimating recreation benefits.

1.2 BACKGROUND: LINKAGES, LIMITATIONS, AND USER BENEFITS

The evaluation of benefits and costs of a regulatory policy depends on a determination of the links between the policy, its technical effects on one or more dimensions of environmental quality, and the behavioral responses of economic entities to the changes in environmental quality. Figure 1-1 illustrates one set of linkages--in this case, those for the proposed water quality standards regulations. The chain highlights the linkages between each aspect of the process, from the regulatory action to the beneficial effects experienced by households or companies. This chain of effects implies that the estimation

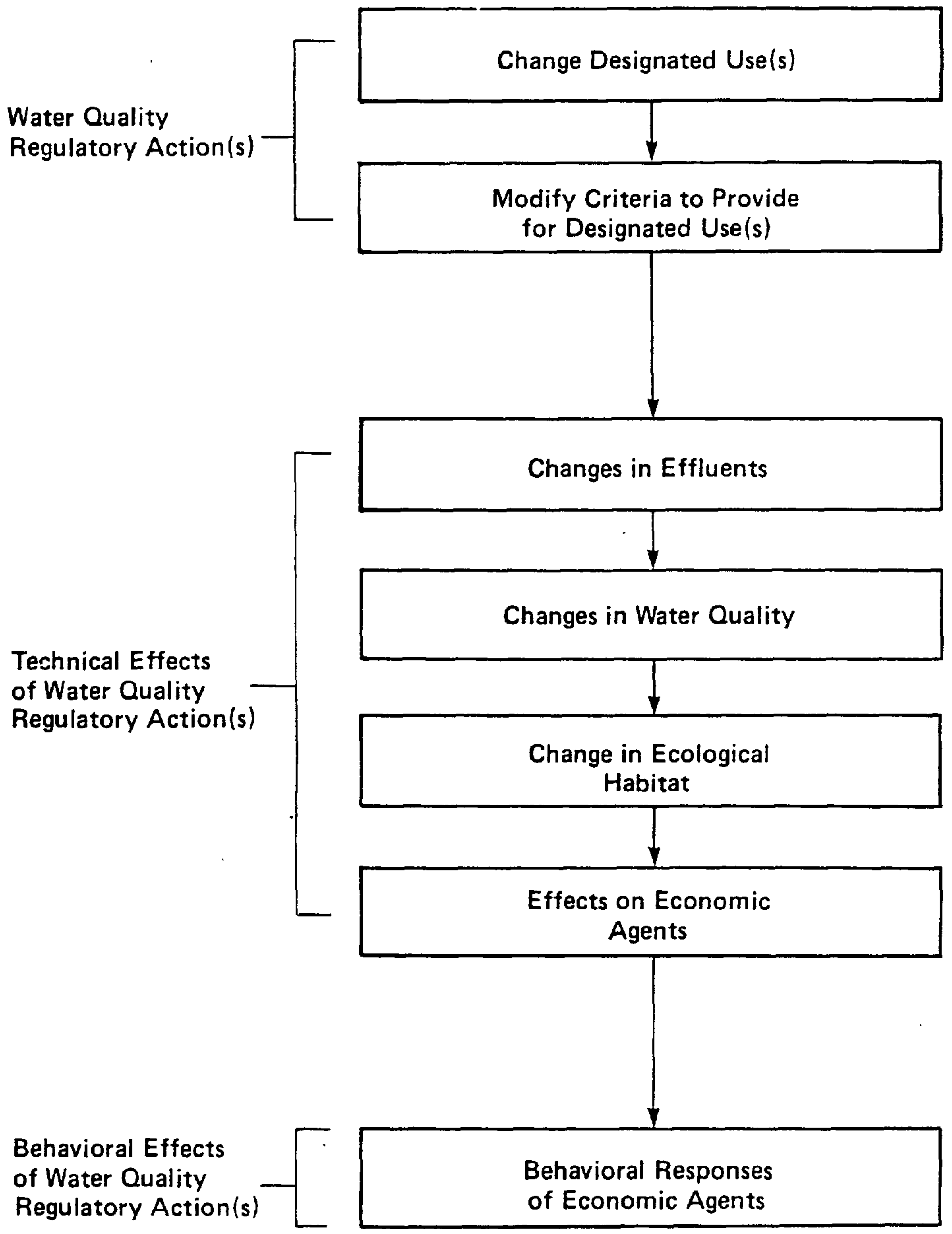

Figure 1-1. Effects and responses to water quality regulatory actions.

of benefits also would depend on how the other links in the chain are modeled. Measuring benefits is only one part of a series of technical and environmental evaluations that are necessary for policy analysis. This report addresses only the last component of Figure 1-1, which involves estimating monetized benefits for regulatory policy.

One of the difficulties of estimating monetized benefits for water quality improvements arises from the absence of organized markets for many of the services derived from water resources. To offset this absence, analysts generally use one of three types of approaches to measure the benefits of water resource regulations: (1) market-based approaches, which use indirect linkages between the environmental goods and some commodities exchanged in markets; (2) contingent valuation approaches, which establish an institutional framework for a hypothetical market; and (3) public referenda. This report considers one type of the indirect market-based approaches--the travel cost recreational demand model.

The model used in this study focuses on water quality as one of a set of characteristics that determines the effective quantity of the recreation services available to the prospective user of a particular site. Effective quantity is simply another way of saying that not all sites provide the same services. Each site, depending on its features, provides services of varying quality. Consequently, any attempt to measure the demand for all sites' services must address these quality differences. The definition of effective quantity does so, by treating the measurement of quantity and quality as part of the general index number problem. In effect, we convert quantity and quality into a single scale--effective quantity.

The generalized travel cost model deals with this index number problem by assuming that site characteristics will affect the services available for recreational activities and will thereby affect demand for the site. Changes in any one of these characteristics can therefore be expected to alter the demand for the site.

Thus, the generalized travel cost model provides the basis for measuring the recreation benefits from water quality improvements by focusing on the demand for site-specific recreation services. As highlighted in Figure 1-2, however, this study considers only the recreation benefits that accrue to users of a recreation site--not those, such as intrinsic benefits, that can accrue to either users or nonusers. An important limitation of the travel cost approach is that its dependence on site-specific demand for recreation services makes it incapable of measuring anything other than the user benefits shown in Figure 1-2.

1.3 OBJECTIVES

The objectives of this study were to extend the previous research on the travel cost model in three ways:

- Develop a clear rationale for valuing specific recreation activities, adapt the model to reflect the rationale, and use it to estimate the differential values of water quality improvements due to differences in the activities undertaken at a site.
- implement a statistical procedure that is more consistent with the character of the available data.
- Estimate the benefits using several different conceptual measures for defining changes in individual well being.

In approaching these objectives, this study ties together several different threads from the established theory of consumer behavior to provide perspective for the problems involved. Moreover, some of the insights derived in

Potential Water Quality Benefits	Current User Benefits	Direct Use	In Stream	Recreational* - fishing, swimming, boating, rafting, etc.
				Commercial - fishing, navigation
			Withdrawal	Municipal - drinking water, waste disposal
				Agricultural - irrigation
				Industrial/Commercial - cooling, process treatment, waste disposal, steam generation
		Indirect Use	Near Stream	Recreational* - hiking, picnicking, birdwatching, photography, etc.
				Relaxation* - viewing
				Aesthetic* - enhancement of adjoining site amenities
	Intrinsic Benefits	Potential Use	Option	Near-term potential use
				Long-term potential use
		No Use	Existence	Stewardship - maintaining a good environment for everyone to enjoy (including future family use-bequest)
				Vicarious consumption - enjoyment from the knowledge that others are using the resource.

* Considered in this project.

Figure 1-2. A spectrum of water quality benefits.

the process extend beyond the travel cost model to other problems involving the estimation and aggregation of the benefits of regulatory policies in general. The problems considered in this study are not unique either to the travel cost model or to the recreation data sets; they are encountered in all types of applied microeconomics research.

A central issue for policy analysis is whether or not the methods selected to resolve these issues affect the estimated benefits sufficiently to influence our ability to address important policy decisions. Do these somewhat technical considerations affect how an analyst would conduct a Regulatory Impact Analysis, or are they only of limited technical interest?

Although new data were collected, this study primarily relied on off-the-shelf data. Frequently, the limited nature of these data required the use of empirical procedures that were more restrictive than theory would have required. In particular, the data available for measuring the diversity of recreation activities were crude proxies that limit the nature of the models that can be considered in appraising their effects. Thus, the ability of the research to meet its objectives has to be viewed in light of the informational constraints imposed by existing data. Nevertheless, the data were of sufficient quality to shed some light on the effects of activities, the estimator, and the benefits measure on the valuation of water quality improvements.

1.4 SUMMARY

This section summarizes the study's major findings in light of the seven issues summarized at the outset of this chapter.

1.4.1 Amending the Generalized Travel Cost Model to Account for Diverse Mixes of Activity

The generalized travel cost model links individuals' demands for the services of a recreation site to water quality and other site characteristics. Amending this model to reflect differing mixes of activities across sites is analogous to the aggregation problem faced by conventional demand studies. In this study, the question is, “How do you add up the various individual demands for a site’s services when different types of activities are undertaken?” This question is especially relevant to the water quality standards regulations, which designate uses that must be attained for specific water bodies. For benefits estimation purposes, the issue is, “How much of the value of improved water quality is attributable to specific uses--e.g., fishing or swimming?”

The central conclusion of Chapter 2, which explores the implications of activity diversity as an aggregation problem, is that, in principle, the model can be amended in a way consistent with the theoretical guidelines. The chapter suggests that an individual’s demand for a site’s services, the basis of the travel cost model, is itself an aggregate demand--the horizontal sum of the demands for specific activities like boating or fishing. This derived demand will differ across individuals to the extent that they undertake different activities. With some fairly restrictive assumptions, the problems posed by the aggregation across activities can be viewed as similar to the role of tastes in conventional demand models. However, aggregation across activities has a significant advantage over attempting to account for the diversity of tastes. Specifically, while it is difficult to unambiguously measure people’s tastes, it should be relatively easy to observe and objectively measure the different activities individuals engage in. In the case of the travel cost model, then, because individuals’ demands can differ, it should be possible to explain why they differ if one knows the activities undertaken.

Presently, the available data limit our ability to amend the generalized travel cost model to completely concur with theory. One of the most flexible approaches to aggregation (Lau's [1982] Exact Aggregation Theorem) would require data on the features of the distribution of the time each individual spends on each activity at a site. In addition, it would require information on the features of the various activities that lead to differences across individuals in their ability to produce them (i.e., in technical jargon, their production functions). Because these kinds of data were unavailable, a compromise strategy was adopted for modeling that followed the spirit and general direction of theory but could not conform to its specific requirements.

The amendment to the generalized travel cost model expands the specifications for the three travel cost demand parameters: intercept, travel cost, and income. Instead of viewing each of these simply as a function of site characteristics such as water quality, the model specifies each as a function of one or more measures of activity diversity and of specific site features known to affect activities--e.g., fish-stocking programs for fishing. The measure of activity diversity is constructed for an average, or representative, user of each recreation site based on the proportion of users who engaged in that activity at that site. Therefore, activity diversity varies only across sites, not among individuals at a given site, which would also have been possible if the data were available.

Despite efforts to reflect activities in the generalized travel cost framework, the amended model was largely unsuccessful. Empirical estimates were unstable; the data were simply not up to the task. However, this evaluation of the theory and practice for considering activities has clearly marked a path for future empirical efforts based on more effective measures of activity diversity.

1.4.2 The Representativeness of the Data

To assess the representativeness of the data used in estimating the travel cost model, this study considered them from both a demand and supply perspective. On the demand side, the characteristics of the users of 43 Corps of Engineers sites were compared with those of the general public and with those users of other Federal Estate lands. While these kinds of comparisons can be treacherous, the objective was not to be precise; rather, it was to make a general comparison in fairly crude terms that would serve to identify broad similarities or differences.

Compared to the general public, users of the Corps of Engineers sites are more likely to be younger, Caucasian, and employed as craftsmen or foremen. They also are more likely to live in rural areas, to have attained slightly higher levels of education, and to earn higher incomes. In comparisons with users of other Federal Estate lands, users of the Corps of Engineers sites are less educated and are less likely to be employed professionals or technical workers. They also earn lower incomes, are more likely to live in rural areas, and are more likely to have visited a site closer to their residences.

If one is interested in transferring the estimated benefits using the model from this study's recreationists to other recreationists, most of the differences discussed above are likely to have little effect. The users of Corps sites are fairly typical of a broad spectrum of the population. The least appropriate case for transferring the results would likely be one that draws users from some population with very unique features that would be expected to affect their recreation decisions. Otherwise, the data from users of Corps sites would seem representative.

On the supply side, this study has compared activities supported by the Corps of Engineers sites with those supported by other water-based sites on State and Federal Estate lands. Generally, all the sites support a broad range of activities, with boating, fishing, swimming, picnicking, and camping the most popular. Differences seem to be most prevalent in less popular activities like horseback riding. The Corps of Engineers sites are representative of sites that support flatwater boating and fishing, as well as extensive camping. Natural free-flowing rivers that support specialized boating and/or fishing seem the poorest matches for the sites in our sample.

1.4.3 The Sensitivity of Estimated Benefits to the Statistical Estimator

The generalized travel cost model in Desvousges, Smith, and McGivney [1983] used ordinary least-squares (OLS) regression to estimate separate travel cost demand equations for each Corps of Engineers site. OLS, which was used in the interest of time and budget limitations, will yield biased estimates given the character of the Federal Estate Survey data on the model's dependent variable, visits. The survey's coding procedure censored this variable on its upper end (the last interval was open ended; i.e., six or more), and its sampling procedure truncated the variable at one (only persons who visited the site were interviewed).*

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*Truncation and censoring imply that the errors in the travel cost demand functions cannot be assumed to follow a normal distribution with zero expectation. If we assume the true errors follow normal distribution but our process of observing them introduces these problems, then their expected value will no longer be equal to zero. The problems will be most serious for sites with observations clumped at either end. Desvousges, Smith, and McGivney [1983] used an adjustment index relation OLS to ML estimates [Olsen (1980)] to gauge the severity of these problems and screened sites that appeared to have the greatest effects on the OLS estimates before estimating the second stage equation used in the benefits calculation.

To accommodate the problems caused by the data's character, the second generation model used a maximum likelihood (ML) estimation approach--designed specifically to reflect the problems of truncation and censoring in the model's error--to estimate the travel cost demand equations (see Chapter 6 for more details). These new estimates are compared with the OLS estimates to evaluate the differences between the two models.*

The second generation model was reasonably successful. The parameter estimates confirm the earlier OLS results that water quality has a significant and plausible effect on the demand for the site; this effect, however, is largely a shift in the demand intercept. In addition, the ML estimates implied smaller per-unit consumer surplus estimates for the Corps sites that are more in line with other empirical findings on the value of water-based recreation. (This will be discussed in more detail in Section 1.4.5.) Yet even these estimates based on an improved statistical estimation procedure are not without limitations. This approach (like OLS) assumes a normally distributed error term, which restricts the generality of the findings. Its estimates also were sensitive to the sample of sites used to estimate the equations. Thus, while the maximum likelihood approach improves the ability to avoid bias as a result of censoring and truncation in the model's errors, it has not completely solved the modeling problems associated with estimating recreation site demand.

1.4.4 The Sensitivity of Benefits Estimates

This study used both Marshallian and Hicksian (based on Hausman [1981]) measures of changes in well being to estimate the benefits of improved water

*Such simple comparisons cannot be used to judge bias in the OLS estimates. Each estimator will have a sampling distribution of its estimates. Our results are simply one drawing from these distributions. Comparisons of these drawings will not provide information on the relationship between the central tendencies of each distribution in comparison to the true values.

quality. The Marshallian measure is the difference between the maximum amount an individual is willing to pay (with given income) and the amount actually paid for a water quality improvement. The Hicksian measure, which is more consistent with theory, holds an individual's utility or well being constant, in measuring the largest payment the individual would make to obtain the water quality change.

Chapter 7 reports the annual benefits estimates for 21 Corps of Engineers recreation sites for two increments in water quality:

- Boatable to fishable
- Boatable to swimmable.

The estimates are provided for both welfare measures and for each of the statistical approaches used in estimating the travel cost demand model.

Several general conclusions emerge from the results in Chapter 7:

- The estimated values of water quality improvements are very sensitive to the benefit concept used. The Hicksian-based measures are, with one exception, greater than the Marshallian estimates. Moreover, the differences are larger than would be expected based on theoretical expectations.

- The value of water-quality improvements is very sensitive to the statistical estimation approach. The OLS-based model predicts estimates that are well above the ML. For many of the sites, the OLS-based estimates are one order of magnitude larger than those based on the ML estimator.

- There is no strong case, on either theoretical or empirical grounds, for preferring one set of estimates over another. The empirical approximations necessary to estimate the Hicksian measure reduced its more desirable theoretical properties. The ML estimates also showed sensitivity to sample composition and the potential for instability in small sample sizes.

1.4.5 The Comparability of the Benefits Estimates

This study also compared the estimated benefits of improved water quality with those from two other recent studies, Vaughan and Russell [1982a] and

Loomis and Sorg [1982]. Table 1-1 reports the estimated benefits from these two studies, from previous research [Desvousges, Smith, and McGivney (1983)], and from the present findings. The table shows only the Marshallian estimates to maintain comparability across studies.

Several conclusions can be drawn from the data in Table 1-1 and from Chapter 8:

- The OLS-based estimates for the 21 Corps of Engineers sites in this study are larger than those from all the other studies.

- The ML-based estimates for the same sites fall within the range of those from the other studies.

- The OLS-based benefits for the Monongahela River are much closer to the range of the other studies than the 21 Corps sites used in this study.

- The Vaughan and Russell [1982a] and Loomis and Sorg [1982] estimates are probably conservative based on the character of their sites or the measurement of travel costs.

- It is difficult to prefer the estimates from one study to those of another. All are sensitive to data limitations, model specifications, and variable measurement.

1.4.6 Implications for Estimating the Benefits of Environmental Regulations

The most important implication of our research findings for conducting future benefit-cost analyses of environmental regulations is that they will be harder to accomplish. This finding necessarily increases the detail required in future efforts to measure the benefits associated with improvements in environmental quality. It is due to several important features of our research or its findings including:

- Technical issues involving choice of statistical estimator and welfare measures have a considerable effect on the estimated benefits of improved water quality.

- High levels of variability in benefit estimates were present even though only the travel cost approach was used to develop them. Since the travel cost approach is one of the most widely used

Table 1-1. A Comparison of the Estimates if the Benefits of Water Quality Improvements[a]

Studies	1982 dollars
Vaughan-Russell [1982a]	$4.68-$9.37
Loomis-Sorg [1982]	$1.00-$3.00
Desvousges, Smith, and McGivney [1983]	$1.04-$2.15
Generalized travel cost model--OLS estimates	$9.35-$86.34 ($3.57-$194.35)
Generalized travel cost model--ML estimates	$0.13-$9.86 ($0.06-$30.27)

[a]A scaling factor 1.593 was used to convert from 1977 to 1982 dollars. The benefits per visitor day are shown in parentheses. More detailed estimates are available in Chapter 8.

approaches for estimating recreation benefits, it has widespread implications. However, it should also be acknowledged that the models linking water quality changes to recreationists' behavior are very recent and all have involved the use of off-the-shelf data sets.

- Benefits estimates for water quality improvements were very sensitive to the characteristics of specific recreation sites and their users. This implies that attempts to develop simple rules of thumb, such as unit-day value measures, will be difficult if not impossible.

- The treatment of uncertainty in benefit-cost analysis can be affected by substantial variability in benefits analysis. This suggests that it will be critically important to identify all sources of uncertainty and to describe how these are treated in the analysis. Interval estimates and sensitivity analyses should be the rule rather than the exception in benefit-cost analyses.

- The existing data sources are not up to the task that benefits analysis demands of them. Frequently, they omit information on key variables--e.g., the opportunity cost of time or the allocation of time among recreation activities--that limits the ability of models to provide more reliable estimates of benefits.

Do these difficulties make the task of performing benefit-cost analyses either impossible or too expensive to be worthwhile? Even in light of the difficulties, our answer is "no." There are still substantial gains from simply using the benefit-cost methodology to organize information on the positive and negative effects of a regulatory action. When carefully executed, the process forces hidden assumptions into the light of day and enables decisionmakers to better focus their attention. The presence of uncertainty, whatever its cause, implies that the decisionmakers' and analysts' task will be more complex than if some of the issues giving rise to that uncertainty could be resolved. However, it is our view that uncertain information is better than none at all. Clearly, there is much to be done to improve our understanding of the issues in using benefit-cost analysis to evaluate environmental regulatory actions.

1.5 GUIDE TO THE REPORT

This report consists of nine chapters. Chapter 1 has introduced the research and summarized its major findings. Chapter 2 develops the conceptual basis for amending the generalized travel-cost model to address the influence of diverse recreation activities. Chapter 3 highlights the data sources and discusses their research implications. Chapter 4 provides extensive information on the characteristics of the Corps of Engineers recreation sites that are used to estimate the travel cost model. Chapter 5 assesses the representativeness of these recreation sites and their users for all water-based outdoor recreation. Chapter 6 describes the empirical results for the amended generalized travel cost model that reflects the character of the data and the inclusion of a diverse mix of recreation activities. Chapter 7 discusses alternative measures of changes in well being and presents the estimated benefits of water quality improvement. Chapter 8 assesses in three parts the implications of benefits variability for conducting benefit-cost analyses. Chapter 9 lists the references cited in this report.

CHAPTER 2

THE CONCEPTUAL IMPLICATIONS OF RECREATION ACTIVITIES FOR THE TRAVEL COST MODEL

2.1 INTRODUCTION

This chapter describes generally the recreationist's decision process and modifies the travel cost demand model to take account of diverse recreation activities based on the household production framework. Specifically it develops the implications of differing recreation activity mixes for estimating the benefits of water quality improvements at a recreation site. The basic approach of the chapter is to view these differing mixes as an aggregation problem once it is acknowledged that an individual's demand for a site is an aggregate, then how that demand can be consistently modeled to reflect its component sources--the recreational activities undertaken on site--becomes an important issue.

Understanding how various demands are added up is also important when the travel cost model is to be used for policy purposes--for example, the recently proposed changes in the national water quality standards. In these programs, specific uses are designated for water bodies, along with the requisite water quality levels, to provide the basis for an emission Criteria for waterborne residuals. Accordingly, any attempt to value the water quality changes from such programs should use a model that explicitly deals with both the effects of water quality on the feasible recreation activity mix--because the specific activities undertaken will affect the nature of that site demand--and the contribution of water quality to each of those individual demands.

Section 2.2 provides some background on travel cost models using the household production framework which is used to describe an individual's recreation decisions. Section 2.3 outlines the basic structure of this framework and considers its relationship to conventional statements of the travel cost models for site demands. This section also discusses the implications of the activity mix for the recent extensions of the travel cost model that account for site attributes. Section 2.4 reviews the general implications of aggregation theory and adapts Lau's [1982] recent extension to the literature on exact aggregation to provide some insight into the problems posed by the diversity of activities. Section 2.5 presents our proposed pragmatic compromise, which appeals to the theory of exact aggregation, to amend the generalized travel cost model using the data available. The amended model will be used in our empirical analysis as a basis for valuing of site attributes under assumptions of varying activity mixes. Section 2.6 briefly summarizes the implications of the analysis in this chapter.

2.2 BACKGROUND

The travel cost model has been one of the most important economic models used to estimate the demand for and the valuation of recreation sites. In early applications of the model, the sites studied supported only one or, at most, a very limited range of activities.* However, more current applications have studied sites that support a wide range of activities, making understanding issues like differences in the activity mix undertaken by recreationists more important,

Based on the household production framework, a travel cost demand function can be viewed as a derived demand for a recreation site's services.† This

*Examples include the Vaughan-Russell [1982a] study of recreational fishing, Cicchetti, Fisher, and Smith [1976] of skiing, and Morey [1981] of skiing.

†In this report, this framework is used to provide a consistent conceptual view of a household's behavior. The travel cost model can be viewed as the operational counterpart of the framework.

framework maintains that members of a household combine market and nonmarket goods and time to produce service flows. For example, households might use rods and reels, a boat, their time, and the services of a reservoir to produce the service flow--fishing. Households are assumed to obtain utility from the recreational services even though their production is unobserved because these services are internal to each household.

The household production framework also provides a conceptual basis for distinguishing between two empirical modeling approaches--recreation participation and travel cost models. In recreation participation models, households choose activities which are approximate descriptions of final service flows from a recreation site. In effect, this approach uses the observed choices households make to boat, fish, or swim. In the travel cost model, households choose to visit a recreation site because it provides services that can be combined with other inputs to produce activities like fishing [see Deyak and Smith, 1978; Smith, 1975; Bockstael and McConnell, 1981; and Vaughan, Russell, and Hewitt, 1984, for further discussion]. In effect, the demand for a site's services are derived from the demands to boat, fish, or swim.

This characterization of behavior in the household production framework seems especially well suited to the modeling of recreation behavior. For example, to engage in a water-based activity such as boating or fishing at a site (i.e., to produce either of these activities as recreation service flows), an individual or the household* must use inputs from market and nonmarket commodities, and his time. In this framework, a unit of a recreation site's services is a factor input that contributes to the production of such activities as

*See Becker [1974] for a discussion of the conditions necessary for these two economic units to be equivalent.

boating, fishing, or swimming. Thus, an individual demands a site's services because of its role in producing one <u>or more</u> of these activities.

While the household production framework has been widely used to classify recreation models, these efforts generally have used simple descriptions of individual behavior.* As a rule they have assumed each individual engages in (or produces) final service flows (activities) that are defined in fairly general terms. For example, these service flows might be specified as a recreation and a nonrecreation activity. This formulation did not appear to be limiting because the models have typically been intended as illustrative devices for describing the logic underlying the interpretation of the travel cost site demand as a derived demand. In the process, however, the studies have overlooked an important aspect of the framework and its implications for empirical estimation. When a site can support a variety of recreational activities, each with differing requirements for equipment, site services, etc., the models of household behavior must recognize that these activities will likely have different production functions associated with each of them. Moreover, a household's derived demand for a site's services will depend on the mix (and respective amounts) of participation in each of these activities. Empirical versions of the travel cost model have implicitly assumed a constant mix of activities across the individual observations in the sample. For models based on individual level data, this assumption implies that the recreationists all engaged in the same composite of activities (or that the technologies for producing each activity are identical).†

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*Examples would include Deyak and Smith [1978], Bockstael and McConnell [1981], and Smith, Desvousges, and McGivney [1983].

†Gallagher [1982] appears to have been the first to recognize this potential difficulty with the travel cost model.

The reasoning underlying this conclusion is straightforward. Assuming that a site's services must be allocated to each activity that is undertaken and that the services are not available as services of a public factor input [see Sandmo, 1973, 1975],* contributing simultaneously to the production of several service flows, then an individual's demand for a site's services is treated as an aggregate demand. It is the horizontal sum of the demands arising from each activity. To the extent that each individual undertakes a different mix of activities during his visits to a site, then the derived demand for a site's services will be different across individuals. In practice, the exact implications of this source of variation are unknown. Indeed, at one level it can be regarded as completely analogous to the implications of heterogeneous tastes in demand models for any product.† One important difference between the effects of activity mix versus taste differences is that some variables can be specified to explain each individual's selection of the mix of recreational activities to undertake at each site.

To evaluate the implications of an individual's activity mix for empirical models of the demand for a recreation site's service, two issues must be addressed: (1) the model's time period and (2) the nature of the household production function that relates each site's services (as an input) to the recreation activities under study (as outputs). In many recreation models, the time horizon is a recreation season. Generally, the model describes the factors that influence an individual's demand for a site's services during the season.

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*Willig [1979] used public factor inputs as one explanation for the existence of economies of scope in production processes.

†In fact, without heterogenicity in tastes, skills, or implicit prices of inputs to household production, we would not observe differences in the mix of activities undertaken by the household.

As noted earlier, if it is assumed that recreation activities are independently produced, then an individual's demand function for a site's services during the season is the horizontal sum of the site demands for each of the recreation activities he undertakes during that period.* Indeed, it need not be assumed that these activities are all undertaken during a single visit. An individual can use a site during one trip for boating and during another for fishing (given, of course, the site permits both activities). Since the time horizon is the season, the demand function will not distinguish these trips in the quantity measure. The "stock" of visits during a season is implicitly assumed to be a good proxy for the flow rate of use which each trip assumed to be motivated by the same considerations.

As a rule in the household production framework's description of the travel cost model, the conventional assumption is that different individuals have identical production technologies, except to the extent that differences can be represented by skill variables. (These are included in site-demand models as shift factors.) However, once the prospects for different uses (or produced activities) in situ are acknowledged, then, despite this assumption of identical production technologies, the individuals can be expected to have different site demands. That is, to the extent that various individuals or households engage

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*There is no reason why the same problem could not be considered using the time onsite for a single trip. Indeed, in some respects this is the simplest framework. It is not clear that the time onsite per trip should simply be aggregated across trips in modeling the effective constraints to an individual's allocation among recreation activities.

We have argued that the number of trips and time onsite per trip are substitutes in the production of recreation service flows. There are good reasons to believe that they are not perfect substitutes.

However, for the purposes of the present analysis we will not consider this problem and will for simplicity assume time onsite is allocated for the whole season (i.e., across the trips undertaken during that season).

in different recreation activities at the same site, their respective "aggregate" demand for the site's services can be expected to be different.

2.3 THE HOUSEHOLD PRODUCTION FRAMEWORK FOR MODELING CONSUMER'S RECREATION DECISIONS

Descriptions of the household production framework of consumer behavior abound in the literature.* Consequently, the present discussion of its features can be brief. The individual is assumed to derive utility from service flows that must be produced within the household. Production requires the inputs of purchased goods or services and of time.† The activities of an individual are usually specified to consist of two dimensions: (1) selecting purchased commodities and allocating time so as to minimize the costs of producing each given level of the service flows and (2) choosing the levels of these service flows so as to maximize utility subject to the constraints of income and the implied prices (i.e., marginal costs of producing) for each of the service flows.

The results of the first set of decisions can be described with a neoclassical cost function: Let $Z_1, Z_2, \ldots, Z_N$ designate the N produced service flows; $P_1, P_2, \ldots, P_K$, the prices of K purchased commodities; $r_1, r_2, r_3, \ldots, r_M$, the implicit prices of trips (the measure of site usage) to each of M recreation sites;‡ W, the wage rate; and $\bar{t}_1, \ldots, \bar{t}_L$, the different types of

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*The household production framework was first introduced by Becker [1965]. It has been widely discussed from both positive and negative perspectives (see Pollak and Wachter [1975], Barnett [1977], and Deaton and Muellbauer [1980b], especially Chapter 10, as examples). Deyak and Smith [1978] and Bockstael and McConnell [1981] discuss its implications for recreation modeling.

†Of course, it can also involve inputs of nonmarket goods such as the Services provided by the ambient environment.

‡The price of trips would include the vehicle-related costs of the trip as well as the time costs of travel. For a discussion of the issues in valuing travel time see Cesario [1976], Wilman [1980], and Smith, Desvousges, and McGivney [1983].

time available to the individual.* In the form of a conventional neoclassical cost function, Equation (2.1) summarizes the results of the individual's production activities. It can be derived from the necessary conditions associated with cost minimization, subject to the constraints associated with each of the N household production functions.

$$C = C(Z_1, Z_2, \ldots, Z_N; P_1, P_2, \ldots, P_K; r_1, r_2, \ldots, r_M; W; \bar{t}_1, \bar{t}_2, \ldots \bar{t}_L) \quad . \tag{2.1}$$

To simplify matters, assume that the first S service flows designate recreation activities. Further, maintain that the activities use the first R purchased commodities and that each can involve one or more or the M sites. In the absence of joint production between the recreation and nonrecreation service flows, C(.) can be rewritten as follows:

$$C(Z_1, Z_2, \ldots, Z_N; P_1, P_2, \ldots, P_K; r_1, r_2, \ldots, r_M, W; \bar{t}_1, \bar{t}_2, \ldots, \bar{t}_L) =$$

$$C_R(Z_1, Z_2, \ldots, Z_S; P_1, P_2, \ldots, P_R; r_1, r_2 \ldots, r_M, W; \bar{t}, \bar{t}_2, \ldots, \bar{t}_L) +$$

$$C_{NR}(Z_{S+1}, Z_{S+2}, \ldots, Z_N; P_{R+1}, P_{R+2}, \ldots, P_K; W; \bar{t}_1, \bar{t}_2, \ldots \bar{t}_L) \ . \tag{2.2}$$

Our concern is with the demands for recreation sites' services. Consequently, $C_R(.)$ will be the primary focus of our attention.

Since there is no joint production of recreation service flows, $C_R(.)$ can be written as the sum of the neoclassical cost functions associated with each recreation activity. This result follows because the services of each of the inputs can be allocated exclusively to distinct production activities. Thus,

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*The concept of different types of time constraining an individual's allocation decisions is discussed in Smith, Desvousges, and McGivney [1983].

Equation (2.3) provides a further refinement in the form $C_R(.)$ implied by these assumptions:

$$C_R(.) = \sum_{k=1}^{L} c_R^k \; (Z_k;\; P_1,\; \ldots,\; P_R;\; r_1,\; r_2,\; \ldots,\; r_M;\; W) \tag{2.3}$$

Of course, in practice not all individuals will produce all L activities or consider using all of the M sites to accomplish these ends.* Consequently, to relate this general description of a consumer's decisions to the circumstances generally described by the travel cost model, consider the specialization of Equation (2.3) to describe the cost functions for users of a particular site. If the site supports a subset of the L activities, then only that subset of the $c_R^k(.)$'s will be relevant to the definition of each individual's demand for the site's services. In the limiting case, if a site supports only one activity (e.g., a fishing site or downhill skiing facility), then only one of the $c_R^k(.)$'s will be relevant. This observation is important because the demand for each site's services can be derived from a neoclassical cost function using Shephard's [1953] lemma for given levels of Z's. For any individual with objectives consistent with our description, it is given in Equation (2.4):

$$v_\ell = \sum_{k\varepsilon\Omega} \frac{\partial c_R^k}{\partial r_\ell} \qquad \ell = 1,\; 2,\; \ldots,\; M \tag{2.4}$$

where

v_ℓ = measure of the quantity demanded of the ℓ^{th} site's services, and

Ω = the set of recreation activities undertaken by the individual at the ℓ^{th} site during the time period relevant for the demand.

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*It is important to recognize that the model we develop in what follows assumes that the selection of activities to engage in (i.e., services to produce) is involved with interior solutions. That is, we have not attempted to deal with the discrete choice or corner solution dimensions of this problem. We will, however, return to this point in Chapter 6.

Consider a simple example to illustrate the implications of this argument. Assume there are two users of the ℓ^{th} site. This facility supports three types of recreation activities (Z_1, Z_2, and Z_3). There are two different reasons for different selections of the recreational activities across individuals. Perhaps the most obvious is tastes. Another equally plausible explanation can be found in identical tastes but differences in the circumstances constraining choices. Examples would include the factor prices (including the wage rate) and the time constraints facing each individual. Such differences could affect the cost minimizing production choices and the resulting marginal costs for each activity and could therefore alter the consumption choices of individuals with otherwise identical tastes (defined over the final service flows) and income.

For our example, the first individual (I) will be assumed to engage in all three activities, while the second (II) will be assumed to participate in only one of them (i.e., to produce Z_1). The site demand equations for these two individuals are then given in Equations (2.5a) and (2.5b), respectively. The superscripts (I and II) added to our measure of site demand v are used to designate each individual.*

$$v_\ell^{I} = \frac{\partial c_R^1}{\partial r_\ell} + \frac{\partial c_R^2}{\partial r_\ell} + \frac{\partial c_R^3}{\partial r_\ell} \tag{2.5a}$$

$$v_\ell^{II} = \frac{\partial c_R^1}{\partial r_\ell} \quad . \tag{2.5b}$$

This difference becomes important once it is recognized that most recreation data bases do not permit an individual's site usage to be disaggregated accord-

*Strictly speaking, these derivatives could be different even for the first activity because under our second explanation some subset of the arguments of the cost functions facing each individual are assumed to be different.

ing to the time spent in specific activities. Consequently, the amount of time allocated to each activity cannot be identified.

This example clearly illustrates the problem. A survey composed of information on a set of individuals' total usage of a particular site (without assignment of the use to specific activities) would not be compatible with the estimation of a single site demand equation based on the behavioral decisions of the users in that sample because, in the extreme, each individual could conceivably have different demand functions. Estimates of the parameters of a travel cost site demand model based on such data would be subject to specification errors. Of course, the severity of these errors will depend upon the disparity in the activities undertaken by users of a given site, as well as on the nature of the differences between the derived demand functions implied by the respective household production functions involved.

Before proceeding to an examination of further implications of this structure, it is important to acknowledge that there is always the prospect for differences in the demand for a good or service across individuals simply as a result of differences in their preferences. Indeed, within the conventional model for describing individual consumption decisions, this provides the rationale for including the so-called proxy measures for taste variables. Thus, one might argue that all this discussion has simply reaffirmed a long standing argument that individuals are different.* Within a conventional model these differences would appear as taste differences.

However, the present argument seems to imply more than this conclusion. The household production framework has distinct advantages because it facili-

*This interpretation would be the one adopted by those who are not predisposed to modeling recreation decisions using the household production framework.

tates the description of _why_ different individuals' site demands might differ. Moreover, that description can be based largely on an objective description of observable differences in what the individuals are undertaking (e.g., different recreational activities in our case). Consequently, it should provide the basis for modeling the diversity in individuals' site demands even though it may not be possible to dissaggregate the time spent onsite into distinct recreational activities. This is the objective of Sections 2.3 and 2.4.

In closing this discussion of one theoretical interpretation for the travel cost model and the general implications of activity diversity for it, it is reasonable to ask how the current approaches to modeling recreation site demands might deal with the problem. Unfortunately, neither of the recent modifications to the travel cost model has considered the problems posed by the diversity of recreation activities undertaken at a site. Both of these amendments attempt to take account of the heterogeneity in recreation sites' characteristics and to use it in the explanation of site demand. The first approach [see Vaughan and Russell, 1982a, and Smith, Desvousges, and McGivney, 1983] uses a varying parameter model. A site's characteristics are assumed to affect the effectiveness of that site's services in the process of producing recreation activities. Consequently, site characteristics should be among the determinants of the variation in the parameters of travel-cost demand models. As noted earlier, these functions are derived demands, and factors that influence the productivity of a site's services should therefore influence those demands. One might argue that the varying parameter models represent attempts to use economic theory and variations in site demands to resolve a quantity index number problem. Namely--how do we consistently measure the services of recreation sites that are heterogeneous?

The second approach--the hedonic travel cost model [see Brown and Merdelsohn [1984]--addresses essentially the same issue, but does so from a somewhat different perspective. It assumes that individuals' actions have already provided the information necessary to resolve a companion problem--the price index number issue for diverse recreation sites. That is, it maintains that individuals know the characteristics of recreation sites and the unit costs (time and vehicle-related) of using each. Therefore, this set of prices and characteristics defines the implicit prices of these characteristics through hedonic price (or travel cost) functions.* With these functions and the individuals' actual decisions, it is possible to estimate their respective demands for characteristics of the sites. Nonetheless, in both approaches (i.e., varying-parameter and hedonic travel-cost) the activities undertaken at these sites are ignored. Indeed, for them to provide plausible descriptions of the nature of site or characteristic demand, activity diversity must be assumed absent.

This is, of course, true for all travel-cost-demand models and is, as noted earlier, analogous to the assumption of identical preferences in modeling commodity demands at the micro level. Consequently, in what follows, the implications of the available theory of exact aggregation for revising the travel cost model of site demand are considered.

2.4 EXACT AGGREGATION AND LAU'S EXTENSIONS

This section describes the general implications of aggregation theory as applied to the two problems posed by diversity in the activity mix undertaken for recreation site demands. The first of these problems is the necessary

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*The exact interpretation of these price functions and their relationship to more common hedonic price functions has not as yet been explored. There is no equilibrium process that gives rise to the locus of price and characteristics confronting the individual. Indeed, it is reasonable to ask whether individuals perceive the price set they face in these terms.

amendment of the travel cost model to account for the diverse activity mix. The second arises with policy uses of the results of travel cost models that take account of site attributes in their descriptions of site demands. As noted earlier, it is often necessary to evaluate the benefits associated with changes in site attributes. An improvement in water quality at a recreation site would enhance the value of the site because it increases the users' willingness to pay for the site's services. These increases will depend on the activity mix which the representative individual is assumed to undertake. Consequently, there is a policy-based need to describe site demands in a way that permits distinguishing the contributions to a site's valuation that are associated with particular activities.

The problems posed by modeling an individual's demand for a recreation site when it is known that each person engages in different recreational activities while onsite have direct parallels in the literature on exact aggregation of demand functions. Each individual is assumed to have a distinct demand function, as in Equation (2.6).

$$x_i^j = f_i^j\,(y^j,\ \bar{P}) \tag{2.6}$$

where

x_i^j = the quantity of good i demanded by individual j,

$f_i^j(\,.\,)$ = individual j's demand function for good i,

y^j = individual j's income, and

$\bar{P}$ = a vector of prices for all goods and services (including, of course, the i^{th} good).

Exact aggregation implies that, when these demands are summed across all individuals, it is possible to represent the aggregate demand with a function in terms of the price vector and some income measure, such as the average income. To examine analytically the conditions under which exact aggregation is possible, it is necessary to inquire as to whether or not the function $g_i(.)$, the aggregate demand function, in Equation (2.7) can be defined.

$$\bar{x}_i = \frac{1}{K} \sum_j x_i^j = \frac{1}{K} \sum_j f_i^j(y^j, \bar{P}) = g_i(\tilde{y}, \bar{P}) \qquad (2.7)$$

where

$\bar{x}_i$ = quantity demanded of the i^{th} commodity for the average individual

K = the number of individuals, and

$\tilde{y}$ = some measure of average or “representative” income.

There are two ways this question can be asked: (1) What are the restrictions to the $f_i^j(.)$'s that would assure the existence of $g_i(.)$ in the absence of requirements that both functions be consistent with the properties implied by utility maximizing behavior? or (2) What additional restrictions are required when both the set of $f_i^j(.)$'s and $g_i(.)$ must be consistent with utility maximizing behavior? Clearly, this second question is more restrictive than the first. Moreover, it probably has greatest relevance to applications that attempt to model the joint decisions of how an individual consumer allocates his resources to all goods and services. Most recreation models are developed in a partial equilibrium context where decisions on other activities and their associated goods and services (as inputs) are assumed separable. Thus, the requirements imposed by consistency with utility maximization are somewhat less important to our question. Nonetheless, the discussion of the aggregation conditions begins with this more restrictive case because its requirements provide a good starting point for understanding the aggregation issues relevant to recreation demand modeling.

Moving from left to right in Equation (2.7), there is a progressive condensation in the information available about.diversity in two variables--the quantity demanded (i.e., the x_i^j's) and the income levels (i.e., the y^j's) across individuals. The first two expressions acknowledge that, when attempting to describe the representative (or in this case the average) demand, a distribution of demands is represented with a single value, $\bar{x}_i$. By contrast, since all individuals in this example are assumed to face the same prices, information is not necessarily lost about the price responsiveness of individual demand. As discussed later in this chapter, this is a crucial dimension to Lau's treatment of exact aggregation. The differences to be represented across individuals must be related to the responses of demand to price changes in a very special way. If they are not, then exact aggregation in Lau's framework cannot be accommodated.

This conclusion will be discussed in greater detail in what follows. At this stage, all that is important is a recognition of the differences in the influence of income versus prices in individual demand function. The former can be expected to vary across individuals while the latter generally does not. Exact aggregation is usually described by the question--can $\sum_j f_i^j(.)$ be replaced by a single function in terms of prices and a summary measure of the incomes by all K individuals (i.e., the $\tilde{y}$)? In terms of Equation (2.7), is the last equality feasible? This is essentially the first question posed above, when are there restrictions to the $f_i^j(.)$'s required for the existence of a $g_i(.)$, the aggregate demand function? Similarly, one might ask whether each of the $f_i^j(.)$'s and the $g_i(.)$ would conform to the theoretical restrictions implied by constrained utility maximization, and this is what underlies the second question given above.

Comparing the last two terms in Equation (2.7), the y^j's have been replaced by a single measure of the income levels across individuals. Therefore, $g_i(.)$ does not depend on the distribution of income across individuals. Consequently, any reallocation of income among the K individuals whose demands are aggregated and underlie $g_i(.)$ will not change the total demand. In effect, the marginal propensity to spend on x_i must be constant across individuals. Thus, for the last component of Equation (2.7) to hold, the individual demand functions must be linear in y^j. Since the prices are constant across individuals, any individual's demand function could be written as

$$x_i^j = a_i^j(\bar{P}) + b_i^j(\bar{P})\, y^j \quad . \tag{2.8}$$

However, this specification does not, in itself, impose any restrictions that would imply either the $f_i^j(.)$'s or the $g_i(.)$ functions are consistent with utility maximizing behavior. If these further requirements are imposed, then the result is the Gorman [1961, 1976] polar form for the utility and expenditure functions. The utility function must be quasi-homothetic so that expenditure functions are linear, but need not pass through the origin (i.e., $y(\tilde{U},\bar{P}) = \theta_1(\bar{P}) + \tilde{U}\theta_2(\bar{P})$, where $\tilde{U}$ = total utility level).*

Most economists would regard these as quite restrictive assumptions for characterizing all of an individual's demand patterns. For example, Deaton and Muellbauer [1980a, p. 151] in discussing exact aggregation note that:

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*When a system of individual demand functions is derived from the maximization of a utility function subject to a budget constraint, it is said to be integrable. When these demand functions are also continuously differentiable, this implies: (1) the demand functions are homogeneous of degree zero in prices and income, (2) the price-weighted sum of these demand functions is equal to income, (3) the matrix of compensated own and cross-price effects is symmetric (4) the quantities demanded are positive, and (5) the matrix of compensated own and cross-price effects must be negative definite for all prices and income levels.

For a discussion of how these properties are used in deriving conditions for exact aggregation, see Jorgenson, Lau, and Stoker [1982].

Viewed as necessary conditions for aggregation, quasi-homothetic preferences or equivalently, linear Engel Curves, are extremely stringent. For example, any commodity not consumed at low budget levels is immediately excluded. Consequently, if linear aggregation is to work at all, it can only do so for broadly defined composites of goods.

As a result, there has been considerable interest in generalizing these results to allow a less restrictive characterization of individual demand. Two such extensions will be discussed before turning to the consideration of their relevance to the travel cost model for site demand. The first of these--designated by Deaton and Muellbauer [1980a] as generalized linearity, and originally introduced by Muellbauer [1975, 1976]--begins with the average budget share for a commodity, $\bar{w}_i$, and requires that this share depend on the vector of commodity prices and what is described as a "representative" level of income.* This level, say y*, need not be the average income and can itself be a function of the price vector and distribution of income. The conditions for exact aggregation beginning from this set of maintained assumptions require that an equation be specified for the expenditure function that is consistent with Equation (2.9):

$$\bar{w}_i = \Sigma_j \frac{x^j}{\sum_j x^j} w_i^j = \Sigma_j \frac{x^j}{\sum_j x^j} \frac{\partial \log y^j (\tilde{U}^j, \bar{P})}{\partial \log P_i} = \frac{\partial \log y^j (\tilde{U}_R, \bar{P})}{\partial \log P_i} \quad . \tag{2.9}$$

Muellbauer [1975, 1976] has demonstrated that each individual's expenditure function $y^j(.)$ must be of the form given in Equation (2.10) and the representative individual's expenditure function, y(.), as described by Equation (2.11):

$$y^j (\tilde{U}^j, \bar{P}) = h^j [\tilde{U}^j, \Theta_1 (\bar{P}), \Theta_2 (\bar{P})] + \Psi^j (\bar{P}) \quad . \tag{2.10}$$

$$y (\tilde{U}_0, \bar{P}) = h [\tilde{U}_0, \Theta_1 (\bar{P}), \Theta_2 (\bar{P})] \quad . \tag{2.11}$$

*It is important to recall that we assume all income is spent, so that the budget constraint is binding. Hence, income equals the total expenditure.

The $\Theta_1(.)$, $\Theta_2(.)$, and $\Psi^j(.)$ functions must be homogeneous of degree one in prices and $h^j(.)$ homogeneous of degree one in Θ_1 and Θ_2. Moreover, $\sum_j \Psi^j(.) = 0$.

A variety of specific forms for these demand functions can be considered by making different assumptions with respect to how the representative income, y^*, is related to the income distribution. However, the price-independent functions have been the only specifications used in empirical applications [see Deaton and Muellbauer, 1980b, and Berndt, Darrough, and Diewert, 1977].

Lau [1977, 1982] has developed a more general approach to this problem. His approach allows the exact aggregate to take account of differences in individual preferences by maintaining that they are related to individuals' demographic characteristics. Moreover, it permits the individual demand functions to be recovered from the system of aggregate demand functions. Jorgenson, Lau, and Stoker [1982] have recently provided a convenient summary of its implications. They note that Lau's fundamental theorem of exact aggregation makes the following assumptions:

- All the individual demand functions for a commodity are identical up to the addition of a function independent of individual expenditure and attributes.

- All the individual demand functions must be sums of products of separate functions of the prices and of the individual expenditure and attributes.

- The aggregate demand functions depend on certain index functions of individual expenditures and attributes. The only admissible index functions are additive in functions of individual expenditures and attributes.

- The aggregate demand functions can be written as linear functions of the index functions. [Jorgenson, Lau, and Stoker, 1982, p. 106]

Assuming different preferences and that demand functions are consistent with utility maximizing behavior, Jorgenson, Lau, and Stoker [1982] derive a special case of the Lau general theorem. It can be written as Equation (2.12):*

$$x_i^j = \frac{\partial \ln \bar{F}_1(\bar{P})}{\partial P_i} \ln F(\bar{P}) + \frac{\partial \ln F(\bar{P})}{\partial P_i} \quad y^j - \frac{\partial \ln \bar{F}_1(\bar{P})}{\partial P_i} \quad y^j \ln y^j$$

$$+ \frac{\partial \bar{F}_2(\bar{P})}{\partial P_i} \quad \bar{F}_1(\bar{P}) \quad G(\bar{A}^j)\ y^j \tag{2.12}$$

where

$\bar{A}^j$ represents a vector of demographic characteristics for individual j.

$\bar{F}_1(.), \bar{F}_2(.)$, and F(.) are functions of commodity prices used in forming Lau's index functions; F is homogeneous of degree one and $\bar{F}_s(.)$ (s = 1,2) are homogeneous of degree zero. G(.) is a function of demographic characteristics independent of the F functions.

Letting

$$a_1(\bar{P}) = \frac{\partial \ln \bar{F}_1(\bar{P})}{\partial P_i} \ln F(\bar{P}) + \frac{\partial \ln F(\bar{P})}{\partial P_i}$$

$$a_2(\bar{P}) = \frac{\partial \ln \bar{F}_1(\bar{P})}{\partial P_i}$$

and

$$a_3(\bar{P}) = \frac{\partial \bar{F}_2(\bar{P})}{\partial P_i} \quad \bar{F}_1(\bar{P}) \quad ,$$

then Equation (2.12) can be seen as a generalization to Gorman's [1961] polar form without the subsistence consumption. That is, Equation (2.12) can be rewritten as

*See Jorgenson, Lau, and Stoker [1982], pp. 132-143 for a derivation.

$$x_i^j = a_1(\bar{P})\, y^j + a_2(\bar{P})\, y^j \ln y^j + a_3(\bar{P})\, G(\bar{A}^j)\, y^j \quad . \tag{2.13}$$

Aggregate demand can be written as

$$\sum_j x_i^j = a_1(\bar{P}) \sum_j y^j + a_2(\bar{P}) \sum_j y^j \ln y^j + a_3(\bar{P}) \sum_j G(\bar{A}^j)\, y^j \quad . \tag{2.14}$$

Consequently, Equation (2.14) can be estimated with aggregate information. Moreover, if the functional assumptions required to derive it are accepted as plausible descriptions of how individuals' demand functions vary, then estimates of the demands for each type of individual included in the aggregate can be derived from the estimates for the "representative" individual. The implications of this last point are important. The Lau theorem permits the model to reflect the reasons for differences in individual demand through the specification of a role for an individual's attributes (i.e., the $\bar{A}$ vector) in the demand function. This is an important advantage. It does, however, imply that the "types of individuals" corresponding to these attributes must be defined. Individuals with the same attributes have the same preferences. Of course, they may not have the same level of demand for individual commodities if they have different incomes or face different prices.

The logic used to derive these results provides the basis for considering the problems posed by recreation diversity for the travel cost model. To begin, the focus will be on the simplest case--the demand for a single site. Once the contributions to this demand from distinct activities are recognized, and certain assumptions are employed, the allocation of time onsite among recreational activities (either during a single trip or at different trips within the season) can be viewed as similar to distribution of income across individuals in the exact aggregation case. In the exact aggregation problem, the distribution of income across individuals is given. Consequently, to use these results for the case of aggregation across activities, the time onsite devoted to each activity must be assumed constant. The diversity in household production functions across recreation activities would parallel the differences in utility functions across individuals. And, finally, the definition of an exact aggregate with or without the assumption of integrability for the budget allocation problem parallels the issue of whether or not cost minimization is maintained in interpreting each activity's contribution to the overall site demand and the "aggregate" (across activities) site demand.

In principle, one could use the Lau logic to resolve the problems posed by individuals engaging in diverse recreation activities onsite. Moreover, if these restrictions to the micro and corresponding aggregate demands were judged plausible, then it is possible to retrieve the individual components from the aggregate demand.* For example, in our case it would be possible to estimate the demand for a site's services and retrieve information on the derived demand for a site's services as if they would be used exclusively in one recreation activity--such as fishing or boating. Indeed, with such information, in principle, it would be possible to define the aggregate site demand functions arising from policies that dedicated a site to one recreation activity (or a predefined mix of such activities). To do so, however, requires some specific information--each individual's distribution of onsite time across activities and a specification of the features of these recreation activities that lead to differences in the household production functions for these recreation activities. For aggregation purposes, the onsite time allocations play a role analogous to the distribution of income across individuals, and the recreation activities are

*We are maintaining the assumption of no joint production and including an assumption of constant returns to scale as sufficient conditions for this conclusion.

analogous to individual attributes. Of course, the specific restrictions on individual demand functions and aggregate demand would not be comparable to the commodity demand case, since onsite time plays a somewhat different role than income in the choice process.*

Relaxing the assumption of a fixed time allocation among activities raises considerable problems for site demand models. By maintaining this assumption, the analysis requires that individuals do not alter the mix of activities undertaken onsite in response to changes in a site's attributes. Clearly, this is restrictive. Nonetheless, by identifying the assumptions necessary for developing a consistent relationship between the aggregate and the activity--specific demands for a site's services, this parallel to Lau's exact aggregation provides a basic outline of an approach that could model the recreational diversity issue in terms consistent with a household production model of the individual's recreation choices. Moreover, this framework identifies the types of information that would be needed to implement the model.

2.5 A PRAGMATIC APPROACH TO REFLECT RECREATION DIVERSITY IN TRAVEL COST MODELS

To adapt the exact aggregation results for the presence of recreation diversity, it is assumed that an ideal quantity index for a site's services can be defined based on the characteristics of each recreation site [see Chapter 7 of Desvousges, Smith, and McGivney, 1983]. This index implies that our model explicitly reflects the contribution that a unit of site services from each of a set of different sites would make to the production of each recreation service

*See Deaton and Muellbauer [1980a], pp. 159-161, for a discussion of the conditions for exact aggregation with a model having an endogenous leisure choice. This would be an important consideration to deriving these results in the general case.

flow. In principle, this index function "explains" why some sites are better substitutes for others and eliminates the need to reflect the prices of substitute sites in the travel cost demand model. It is, however, a very restrictive assumption and was necessitated by the information that was available to estimate these site demands. As described in Desvousges, Smith, and McGivney [1983], the data set used for our empirical analysis did not provide information on any individual's available options for substitution. It reported the patterns of use of a set of sites during a particular season based on an onsite survey of users.

Nonetheless, the survey did include a sufficient number of sites with differing characteristics to permit a two-step implementation of the varying parameter model used by Russell and Vaughan [1982]. The first step estimated individual travel cost demand functions for each of a set of 43 Army Corps of Engineers' sites providing water-based recreation. The second used the characteristics of the sites as determinants in models that attempted to explain the variation in the estimated demand parameters across sites. This formulation of the empirical model is consistent with what would be expected from the analytical description of the role of site characteristics for an individual's decisions on recreation activities. The empirical analysis of the implications of recreation diversity will also be undertaken using this data set. Consequently, it is constrained by the information that is available.

The analysis of the exact aggregation results suggests that to take account of this problem it is important to know (1) how individuals allocate the time they spend onsite during the time horizon of the model (in our case, a season) and (2) what features distinguish the household production technologies for the set of recreational activities undertaken at these sites. Unfortunately, neither set of information is readily available. The amount of time each individual devotes to specific recreation activities is not known. Moreover, to date, no attempt has been made to understand the specific details of "producing each type of recreational activity." Consequently, the approach described here must be recognized as a crude adaptation of the logic underlying the conditions of exact aggregate relationships. While it relies on rather poor proxy variables, our approach will attempt to measure variables that parallel the theoretical requirements of Lau's exact aggregation. These variables will be of two types:

- Measures of the distribution of time among activities
- Attributes of the activities undertaken or of the site that might lead to differences in the household production technologies or these activities.

The specific measures used will be described in Chapter 3. In all cases measures of time allocation among activities are for the "average" user of each site and not for each individual. Accordingly, it was not possible to estimate models comparable to Equation (2.14) with individual data for each site. Rather our approach has been to extend the set of determinants used in our two-stage or Varying parameter models to include (1) measures of the distribution of time among activities for the "average" individual; and (2) measure of those site features which might be associated with differences in the production functions or different recreation final service flows.

More specifically, the model maintains that a measure of site demand for individual j at the s^{th} site, v_s^j, during a season (including all uses of the facility) is a function of the travel cost (including both vehicle and travel time components), r_s^j, income, y^j, as well as other socioeconomic variables, $\bar{S}\bar{E}^j$, as given by Equation (2.15) in general terms.

$$v_s^j = \Phi_s(r_s^j,\ y^j,\ \bar{S}\bar{E}^j;\ \beta_s) \tag{2.15}$$

where

β_s = parameter vector for the s^{th} site demand function (with D elements).

Our theoretical analysis of the role of site characteristics suggests that the demand parameters from each travel cost model will be functions of the site characteristics. These characteristics lead to differences in the productivity of the site's services in producing each recreation service flow. A direct application of the Lau theoretical analysis would permit the specification of the travel cost demand functions for each site to be functions of the variables measuring the allocation of an individual's time onsite to different activities. This formulation would parallel the role of the A^j's in Equation (2.14). Since this information is not available, it is assumed that the mix of activities undertaken by individuals at each site is the same for all users of that site. It can, however, vary across sites. Variation across sites would permit measures of the "average" user's selections of activities to play a role analogous to the A^j's in Lau's framework. Of course, these measures of the recreation mix will only vary with site. Thus, if Equation (2.16) describes the original form of the generalized travel cost model [see Chapter 7 of Desvousges, Smith, and McGivney, 1983, for more details], then Equation (2.17) provides a statement of our extensions:

$$\beta_s^k = H_k(\bar{C}_s) \tag{2.16}$$

where

$\beta_s^k = k^{th}$ element in the parameter vector for the s^{th} site.

$$\beta_s^k = \tilde{H}_k\ (\bar{C}_s,\ I_s,\ \tilde{C}_s)\quad k = 1,\ 2,\ \ldots\ D \tag{2.17}$$

where

$\bar{C}_s$ = a vector of site characteristics that are assumed to affect their productivity for recreational services,

I_s = a vector of variables measuring the average individual's allocation of time among recreational activities at the s^{th} site during the season, and

$\tilde{C}_s$ = a vector of variables measuring site characteristics considered to be important to different recreational activities production processes.

An example will provide a tangible description of this process. Our original model specified the logarithm of trips to a given recreation site, v, to be a linear function of the travel cost (including round trip travel time and vehicle related costs) and income as in Equation (2.18):

$$\ell n\ v = b_0 + b_1\ r + b_2\ y\ . \tag{2.18}$$

The second stage then attempted (with a generalized least squares estimator) to explain variation in the estimates of each parameter across sites by the physical characteristics of the sites including water quality as, for example, in Equation (2.19) for the case of the coefficient for the travel costs.

$$\hat{b}_1 = \gamma_0 + \gamma_1 c_1 + \gamma_2 c_2 + \ . \ . \ . \ \gamma_k c_k\ . \tag{2.19}$$

Our pragmatic proposal amounts to simply expanding the set of determinants for each estimated site demand parameter including variables measuring the <u>average</u> user's participation patterns in the activities supported by each site as well as any additional physical characteristics that might be particularly important to specific recreational activities, as illustrated in Equation (2.20).

$$\hat{b}_1 = \gamma_0 + \gamma_1 c_1 + \gamma_2 c_2 + \ . \ . \ . + \gamma_k c_k + \gamma_{k+1}\ a_1 + \ . \ . \ . + \gamma_{k+n}\ a_n + \gamma_{k+n+1}\ d_1 + \ . \ . \ . + \gamma_{k+n+m}\ d_m \tag{2.20}$$

where

$a_1, \ldots, a_n$ = measures of average individual's participation in each of the n activities offered at each site

$d_1, \ldots, d_m$ = characteristics of the site important to particular activities.

Clearly, this approach is somewhat ad hoc. It uses only the general form of the variables found to be important to aggregate demand functions derived using the Lau exact aggregation results. However, in the absence of more detailed information, it offers an approximation that incorporates the central idea implied by the literature on exact aggregation.

It is important to acknowledge that an important source of variation in the site demand models is lost--that is, each site users' selections of recreation activities. The same potential specification errors caused by ignoring activity mix will remain in our modification, because there is no information on the amount of time each of our survey respondents spent at various activities during their trips to the site for the season. Our approach implicitly maintains that the variation in these selections is greater across sites than it is within each site. Hence, by accounting for the variation in the "average" user's activities for each site, there is some basis for capturing this inter-site variation in activities. Moreover, this approach may well serve to provide some basis for judging the empirical importance of the diversity of recreation activities undertaken at a site for travel cost demand models.

2.6 SUMMARY

This chapter has provided a brief summary of the household production model as a framework for deriving the travel cost demand model. Our specific objective was to consider the implications of recreation diversity for the travel cost demand model. Recreation diversity is a term we have used to describe the possibility that an individual can participate in several activities during the time periods usually represented within a travel cost demand model. Often these models are intended to describe the demand for a site's services during a season. Nonetheless, even during a single visit, individuals may allocate their time among a variety of activities. This pattern appears to be a common characteristic of recreation sites that support a range of activities, such as boating, fishing, and swimming. It implies, assuming these activities are not jointly produced, that the derived demand for a site's services is actually an aggregate of the demands arising from each of these activities and, therefore, the travel cost site demand function may well differ across individuals.

In order to explore how this problem might be modeled, the key results from the literature on the exact aggregation of demand functions were reviewed. The appraisal suggests that there is a very clear parallel between the two problems--one that can provide the basis for consistently modeling recreation diversity within a travel cost framework. However, the information necessary to implement the model is presently not available.

Accordingly, an ad hoc amendment to the generalized travel cost model is proposed in order to attempt to reflect some of the implications of recreation diversity. It assumes that the individuals using each site have the same demand functions (i.e., undertake the same mix of recreation activities), but that these activity mixes can vary with site. This is clearly a restrictive assumption and should be regarded as a first step toward judging the importance of recreation diversity for the travel cost model.

CHAPTER 3

DATA: SOURCES AND VARIABLE MEASURES

3.1 INTRODUCTION

This chapter describes the data used in this study and explores its implications for the generalized travel cost model. The data used to estimate the model are for a sample of 43 Corps of Engineers sites that support water-based recreation. The data for these sites are drawn from four sources: the Federal Estate Survey portion of the Heritage Conservation and Recreation Service's 1977 Outdoor Recreation Survey, the Corps of Engineers' Recreation Resource Management System, the U.S. Geological Survey's National Water Data Exchanges, and personal correspondence with the site managers. These sources provide data on both the users of the sites--e.g., visits, origin, and socioeconomic characteristics--and on the sites themselves--e.g., size, location, and water quality.

The character of these data has important implications for the estimation of the model. The data on recreation visits, the measures of activities undertaken at the various sites, and the onsite survey procedures are especially crucial to the generalized travel cost model. This chapter discusses each of these data issues along with the construction of the key variables used in the model. It concludes with a brief profile of several characteristics of the 43 Corps of Engineers recreation sites, of their users, and of the activities provided.

Specifically, Section 3.2 briefly reviews the primary data sources. Section 3.3 discusses the pros and cons of onsite surveys and the problems caused by multiple visits. Section 3.4 describes the data on visits, activities, and travel costs. Section 3.5 profiles the Corps of Engineers sites, their users, and the activities undertaken. Section 3.6 concludes the chapter with a summary of its main points.

3.2 SOURCES OF DATA

This section describes the four major sources of data for this study. It highlights the nature of each data source, the rationale for using each data source, and the complementarity between sources.

3.2.1 The 1977 Federal Estate Survey

The 1977 Nationwide Outdoor Recreation Survey was conducted by the Heritage Conservation and Recreation Service as part of the Department of Interior's mandate to periodically develop National Recreation Plans. In contrast to past recreation surveys, which only included a general population component, the 1977 survey included general population and site-specific user surveys.

The Federal Estate Survey component of the survey, the primary basis of this study, consists of interviews with recreationists at each of a set of recreation facilities. All federally owned areas with public outdoor recreation were considered to comprise the Federal Estate, and sites were chosen on a basis of specific agency control. The majority of interviews were conducted in areas managed by the National Park Service, the National Forest Service, the U.S. Army Corps of Engineers, and the Fish and Wildlife Service. Each agency was then stratified by Federal Planning Regions, and areas were randomly chosen with weight given to annual visitation in 1975.

Interviewing time at each site was based on visitation, which also determined the number of interviews. The final Federal Estate Survey contains 13,729 interviews over 155 recreation areas. Information collected for each respondent included socioeconomic characteristics, current outdoor recreation activities, and attitudes toward recreation. Data requirements for developing travel cost models that describe demand for individual recreation sites are met by the Federal Estate Survey. For example, the survey included questions on each respondent's origin, time spent in travel, number of visits, and time spent at the recreation site. All are necessary elements of a travel cost model. However, some important variables also were omitted. The sites that the respondent considered substitutes and the allocation of time between activities were among the most serious omissions. Thus, not only is the nature of the data collected in the survey important to understanding the application of the travel cost model, the effect of the omitted variables is equally crucial.

Given that the scope of this study is water-based recreation and that the analysis requires detailed descriptions of the activities at each site, only U.S. Army Corps of Engineers sites were chosen for modeling. These 46 sites also ensured consistent management of recreation activities. Three were eliminated from the analysis because of data inconsistency or ambiguous interview site locations. Table 3-1 shows the schedules of the interviews at the Corps of Engineers.

3.2.2 Recreation Resource Management System

The U.S. Army Corps of Engineers maintains the Recreation Resource Management System for evaluation and planning. Data from this system are compatible with the sites chosen for the Federal Estate Survey and have been available since 1978. Information is collected annually on each water resource project with 5,000 or more recreation days of use. For 1978, this information included financial statistics, facilities available, natural attributes, recreation participation, and number of employees.

Table 3-1. Schedule of Interviews at Corps of Engineers Sites

Property code	Site name	Number of interviews	Dates in 1977 for survey
300	Allegheny River System, PA	77	June 2-6
301	Arkabutla Lake, MS	74	July 21-24
302	Lock and Dam No. 2 (Arkansas River), AR	46	August 12-16
303	Beaver Lake, AR	269	July 25-Aug. 8
304	Belton Lake, TX	64	June 18-21
305	Benbrook Lake, TX	43	July 24-27
306	Berlin Reservoir, OH	100	June 8-12
307	Blakely Mt. Dam, Lake Ouachita, AR	48	June 2-5
308	Canton Lake, OK	88	June 8-12
309	Clearwater Lake, MO	82	July 14-17
310	Cordell Hull Dam and Reservoir, TN	116	August 3-7
311	DeGray Lake, AR	50	June 16-19
312	Dewey Lake, KY	47	August 24-28
313	Ft. Randall, Lake Francis Case, SD	61	July 20-24
314	Grapevine Lake, TX	94	July 29-23
315	Greers Ferry Lake, AR	223	June 28-July 10
316	Grenada Lake, MS	78	June 18-22
317	Hords Creek Lake, TX	59	August 4-7
318	Isabella Lake, CA	59	June 2-6
319	Lake Okeechobee and Waterway, FL	35	June 9-13
320	Lake Washington Ship Canal, WA	51	June 3-6
321	Leech Lake, MN	55	July 27-31
322	Melvern Lake, KS	56	July 22-25
323	Millwood Lake, AR	55	June 23-26
324	Mississippi River Pool No. 3, MN	58	August 10-14
325	Mississippi River Pool No. 6, MN	76	July 1-4
326	Narrows Dam, Lake Greenson, AR	48	June 6-8
327	Navarro Mills Lake, TX	46	July 4-7
328	New Hogan Lake, CA	51	June 25-28
329	New Savannah Bluff Lock & Dam, GA	47	July 29-Aug. 2
330	Norfork Lake, AR	52	July 12-15
331	Ozark Lake, AR	54	July 20-24
332	Perry Lake, KS	52	August 4-7
333	Philpott Lake, VA	42	August 9-12
334	Pine River, MN	77	August 4-7
335	Pokegama Lake, MN	78	July 14-17
336	Pomona Lake, KS	61	July 21-Aug. 1
337	Proctor Lake, TX	52	July 28-Aug. 1
338	Rathbun Reservoir, IA	66	August 11-14
339	Sam Rayburn Dam & Reservoir, TX	70	June 28-July 2
340	Sardis Lake, MS	226	June 24-July 4
341	Stockton Lake, MO	43	July 17-20
342	Tombigbee River, AL	39	June 3-6
343	Waco Lake, TX	79	June 23-26
344	Whitney Lake, TX	225	June 28-July 10
345	Youghiogheny River Lake, PA	81	June 23-26

NOTE: See U.S. Department of the Interior, 1979, Heritage Conservation and Recreation Service, for more details.

The Recreation Resource Management System is used to define attributes of the 43 Federal Estate Survey sites. Attributes of an area considered include land area, shore miles, pool elevation, the number of multipurpose recreation areas, and facilities provided.

3.2.3 National Water Data Exchange

The National Water Data Exchange (NAWDEX) is a membership of water-oriented organizations and is a major source of water quality information. The NAWDEX system is under the direction of the U.S. Geological Survey, and its primary function is to exchange data from various organizations. Major sources of information are usually State agencies, the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the U.S. Environmental Protection Agency (EPA). All water quality data used in the analysis were retrieved from NAWDEX in a series of steps. Collection of useful water quality data was completed by identifying potential monitoring stations and by then obtaining actual data. Potential monitoring stations were identified by defining the recreation area in terms of latitude and longitude. A general retrieval was then obtained that listed station name, location, parameter collected, years of data collection, and agency responsible for the data collection. For more details on the issues in using water quality data see Desvousges, Smith, and McGivney [1983].

3.2.4 Personal Correspondence

After using the three main data bases in our previous analyses, three major deficiencies in the information on the sites were identified: inadequate water quality data, insufficient information on unique attributes, and incomplete understanding of the nature of the site's use. To remedy these deficiencies, the project staff contacted by telephone the managers of each of the 43

Corps of Engineers sites. The managers' cooperation was excellent, with data on all 43 sites provided both in the initial telephone conversation and in subsequent written communications. This correspondence yielded water quality data (on all but one of the sites), extensive attribute data, and data on several key variables such as site congestion and substitutes. Because of the extent and diversity of the information received, the site attribute data and the variable information are discussed in both Chapters 4 and 5.

In summary, the data sources used in this study, combining the best available information on a diverse group of recreation sites, were supplemented by efforts to fill in any gaps. The data sources were highly complementary with detailed coverage on users and site features. Yet, the character of these data raised analytical questions.

3.3 SURVEY ISSUES

This section discusses two key survey issues that affect the use of the Federal Estate Survey data in models to estimate the benefits of water quality improvements: the onsite nature of the survey and the potential bias caused by multiple visits by site users.

3.3.1 Onsite Survey

The Federal Estate Survey elicited information from a sample of users onsite at each of the 43 Corps of Engineers sites. This type of survey frequently is used in outdoor recreation studies because it enables the users of the site to be more easily identified than in a general household survey. The users are important because they are the primary respondents who can provide the desired data based on visits to the site. These surveys are not without disadvantages--they usually require complex field procedures to accommodate multiple access points, time periods, and impatient recreationists. But in general, that the advantages outweigh the disadvantages has led to the popularity of onsite surveys in outdoor recreation studies.

An important analytical consequence of the onsite survey is that it provides no information on those individuals who chose not to visit the site during the time of the survey. This has four important implications for using the data in models. First, the surveyed individuals must be assumed to be representative of the preferences of the visitors from other times of the year. This assumption is frequently used and presents problems only in cases in which the survey period was too short to cover the full range of users, or the survey was conducted during a unique time (e.g., during some special celebration or event). Given the information available in the Federal Estate Survey, the special events do not seem problematic, but the time periods (see Table 3-1) were very short and were conducted only during the expected heaviest use periods of the summer. To the extent users at other times of the year differ from visitors during peak times, the sample will be nonrepresentative. In their correspondence, the Corps managers generally did not express much concern over the potential severity of this problem.

Although the second implication of onsite surveys is less apparent than the first, it is equally important. By excluding potential visitors to the site, there is no information on the price (or travel cost in the travel cost model) at which the individual would choose not to visit. In effect, it was impossible to know the reservation or “choke” price for visitors or potential visitors. Either this price or the attributes of the site (or both) caused the individual not to use a particular site. For purposes of benefits estimation, this means some ad hoc assumption will be required to calculate the consumer surplus estimates. (These estimates require the data on the choke price to establish an upper limit for the Marshallian consumer surplus and the Hicksian welfare measures.)

The third implication is that onsite surveys provide no information on the variables that influence the decision to participate. In other words, all the sampled individuals have decided to participate and nothing is known about those who have chosen not to participate. If the determinants of the decision to participate differs from those on how much to participate, the onsite surveys will be unable to shed any light on this question.

Finally, related to our second implication, onsite surveys create econometric problems in trying to specify the correct model because they truncate the measure of use (visits) at one. The truncation occurs because only visitors are interviewed; there are no data for nonusers who would have made no visits to the site. The nature of these errors and their implications for the econometric models used are discussed in Chapter 6.

3.3.2 Multiple Visits

The potential bias caused by having a nonrepresentative share of visitors who made multiple visits is the second survey problem discussed in this section. Multiple visits create problems in an intertemporal onsite survey because the more frequently the individual visits the site during the survey period, the higher his chance of being selected for the survey. In statistical terms, multiple visits create multiple opportunities for entering into the sampling frame used in the survey. The potential bias occurs in the measure of use: the number of visits for the sampled individuals is greater than that for the population of visitors as a whole. The extent of the bias for the Federal Estate Survey Corps of Engineers sites is unknown, but the relatively short survey periods at any one site should minimize the potential problem. However, the short survey periods have the other undesirable effect noted above, they raise the likelihood of the problem of the survey period not being representative of the entire recreation season.

3.4 DATA CHARACTER

This section discusses the character of the Federal Estate Survey data on visits, activities, and travel costs. This character is influenced by the variable definitions, the Survey's coding procedures, and the transformation for our analysis. Specifically, the visit data were coded as intervals with limits on the upper end (i.e., six or more visits); the records of participation in the activities were not classified in a mutally exclusive format nor was time allocated among activities; and only the respondent's Zip code and time-related data were collected. The implications of each of these facets of the data for the generalized travel cost model are examined.

3.4.1 The Quantity Measure: Visits

The number of visits to a site provided the quantity measure for use in the generalized travel cost model. To obtain this measure, the respondent provided an estimate of the number of previous trips to the site exclusive of the one during which the interview was conducted. To code the responses fort this variable, the interviewers grouped the responses in intervals (e.g., one or two times) with the last interval open ended--i.e., five or more trips. Our coding procedure then added one to each of these points to reflect the visit that contained the interview. As noted, this variable also is truncated at its lower end, one, because the survey was conducted onsite. In the analysis, the midpoint of an interval was used. (For example, two visits were used to represent the one to three interval.) Open-ended intervals were converted using the previous interval, with the difference between the previous interval's midpoint and minimum value added to the open-ended minimum value. (Two was added to the open-ended interval six or more and coded as eight for the original OLS analysis only. The ML analysis used six.)

These features of the visit variable had two important implications for the use of the travel cost model. First, its truncated and censored character implies that the conventional OLS estimate will be biased and that a maximum likelihood (ML) estimate will be required to avoid this bias. Second, the benefit estimates may be sensitive to the treatment of the dependent variable--our measure of use. The sensitivity of the predicted benefits to the character of the dependent variable will be evaluated in Chapter 7 to assess its importance relative to other features of the data or model.

3.4.2 Activity Measures

The Federal Estate Survey, by extensively listing activities for each respondent, provided the basic information to account for the diversity of activities in the generalized travel cost model. The diversity of activities at a site is measured as the percent of total respondents who engaged in the various activities at a site. The percentages do not sum to one because some respondents participated in more than one activity during the visit. These activities were recorded only for the visit during which the interview was conducted, implying that one visit has to be typical of all the respondent's visits regardless of the season.

In addition, the survey did not provide the allocation of time at the site between activities, which limits the model's ability to account for activity diversity across the users of a single site. For the generalized travel cost model, the character of the activity data implied that diversity will be modeled using differences in the mix of activities across the various sites. This is a more restrictive assumption than would be dictated by aggregation theory discussed in Chapter 2.

3.4.3 Distance Cost Component of Travel Costs

One component of the model used in this report is the travel cost of a trip, which is defined as the number of miles traveled multiplied by a per mile cost. An independent estimate of travel cost was developed by measuring each respondent's actual road distance traveled to a site based on his reported zip code. All distances were calculated with the Standard Highway Mileage Guide [Rand McNally, 1978], which lists road miles between 1,100 cities. National interstate highways and primary roads were used in all calculations. Other routes were used only for the distance to the nearest primary road. In cases where cities have multiple zip codes, the center of the city was used as the origin.

The second part of the travel cost calculation requires a per-mile cost of a trip. The marginal cost of operating an automobile in 1976 is estimated to be approximately $0.08 per mile. This estimate is based on costs of repairs and maintenance, tires, gasoline, and oil as reported by the U.S. Census Bureau in the U.S. Statistical Abstract [1978]. Mileage costs for operating an average automobile were then calculated by using the round trip miles to the site multiplied by $0.08. This assumes that the respondent drove directly to the site using the routes in the Standard Highway Mileage Guide. Unfortunately, information was not available on other passengers who might have shared these costs or on the primary purpose of the respondent's trip or further driving plans.

3.4.4 Time Cost Component of Travel Costs

The Federal Estate Survey includes annual household income of respondents but does not indicate any hourly wage rate. Some studies have used income in calculating opportunity cost of time, but this approach is likely to preclude the use of income in the site demand models. Moreover, it is family income and a poor basis for judging the effective opportunity cost of time devoted to recreational activities. Thus, an independent estimate of each individual's wage rate is important to a complete specification of the model.

A hedonic wage model estimated from the 1978 Current Population Survey (CPS) was used to derive these estimates. This model specifies the market clearing wage rates to be a function of individual-, job-, and location-specific characteristics. The specific model was developed by Smith [1983]. For details of the use of this model, see Desvousges, Smith, and McGivney [1983].

The estimated 1977 nominal wages for the recreationists at each site were developed based on the hedonic wage model using nominal wages as the dependent variable. The characteristics necessary for the model were generally available in the Federal Estate Survey, and classifications between the model and the survey were compatible. Problems do arise, however, for respondents who were not labor force participants at the time of the survey. For example, students and housewives could not be considered in the sample used to estimate the hedonic wage model. In these cases, the wages were treated as an opportunity cost estimated to be the mean value by sex of the predicted wage rates in the recreation survey. Table 3-2 provides a summary of predicted hourly wage rates by income and occupation of the respondents. The predicted wage rate is used to calculate the opportunity cost of both onsite time and travel time. For at least two reasons, there are substantial differences in these

Table 3-2. Summary of Predicted Hourly Wage Rates (1977 $)

	Total sample	Male	Female
Overall mean	5.44	6.27	4.34
Number of observations	3,460	1,971	1,489
Mean by annual household income[a]			
Under 5,999	5.08	5.79	4.06
6,000 to 9,999	4.92	5.49	4.10
10,000 to 14,999	5.32	6.01	4.38
15,000 to 24,999	5.72	6.70	4.39
25,000 to 49,999	5.98	7.17	4.65
50,000 or more	5.73	6.53	4.65
Mean by occupation of respondent[b]			
Professional, technical, and kindred workers	7.05	7.89	5.65
Farmers	5.15	5.71	2.75
Managers, officials, and proprietors	7.17	7.74	4.94
Clerical and kindred workers	4.34	5.94	4.10
Sales workers	5.18	6.24	3.29
Craftsmen, foremen, and kindred workers	5.89	6.05	4.31
Operatives and kindred workers	4.97	5.15	3.56
Service workers	4.11	4.71	3.18
Laborers, except farm and mine	4.44	4.74	3.11
Retired widows	5.92	6.27	4.34
Students	5.30	6.27	4.34
Unemployed	5.46	6.27	4.34
Housewives	4.37	6.27	4.34
Other	5.71	6.27	4.34
No occupation given	5.49	6.27	4.34

[a] Total number of observations is 3,282.
[b] Total number of observations is 3,460.

estimates for the upper income members of the sample. The first stems from the coding of the wage measure in the Current Population Survey. Specifically, the reporting format limits the reported usual weekly earnings (the basis for the hourly wage rate--usual weekly earnings divided by usual hours worked) to $999. Thus, there is censoring in wages for individuals above approximately $52,000 per year. The second reason is that family income can reflect the effects of nonwage income and the impact of dual earner households. Unfortunately, the extent of these influences cannot be sufficiently determined to improve wage rate estimates for individuals in these higher income households.

3.5 SITE AND USER PROFILE

This section describes the general features of the 43 Corps of Engineers sites, summarizes several key socioeconomic characteristics of the users of these sites, and profiles the activities at these sites.

3.5.1 Site Profile

Table 3-3 summarizes data on three key site characteristics: recreation days, shoremiles, and area. Recreation days are a summary measure of the overall level of use at the sites. This variable clearly indicates the difference in the amount of recreation supported by these sites. Many are very popular recreation sites. Of the 43 sites, 19 provided more than 2,000,000 recreation days. Grapevine Lake supported the largest number of days (5,139,100). Ten of the sites provide fewer than 1,000,000 recreation days with New Savannah Bluff Lock and Dam the fewest (207,600).

The amount of shoreline (measured in shoreline miles) and the site areas also reflect the diversity among the 43 sites. The shorelines ranged from 11 miles at Hords Creek Lake, Texas, to 690 miles at Lake Ouachita, Arkansas.

Table 3-3. The Characteristics of the Sites and the Survey Respondents
Selected from the Federal Estate Survey

Project name	Site characteristics: Property code	Site characteristics: Recreation days	Site characteristics: Shore miles	Site characteristics: Area acres	Characteristics of survey respondents: Predicted wage rate x̄	Predicted wage rate σ	Household Income x̄	Household Income σ	Visits x̄	Visits σ	(T+M) Cost x̄	(T+M) Cost σ	Miles[a] x̄	Miles[a] σ	Number of observations[b]
Allegheny River System, PA	300	-	-	-	5 45	1.65	15,667	8,625	2 6	2.5	45 19	28.30	106	57	69
Arkabutla Lake, MS	301	2,011,700	134	52,549	5.23	1 45	13,184	8,974	5 4	2 7	20 04	27 91	45	90	61
Lock & Dam No. 2 (Arkansas River Navigation System), AR	302	343,700	96	32,415	5 24	1.03	10,409	3,991	6.8	2 0	3.04	13.01	55	33	41
Beaver Lake, AR	303	4,882,600	449	40,463	5.59	1 70	18,150	9,946	3.5	3 0	94 55	88 64	266	296	226
Belton Lake, TX	304	2,507,000	136	30,789	5.52	1 51	17,279	11,913	6 0	2.8	33 18	52 35	67	142	53
Benbrook Lake, TX	305	1,978,000	37	11,295	5 00	1.21	19,135	10,065	2 3	1.2	30.23	58.93	73	223	46
Berlin Reservoir, OH	306	1,179,000	70	7,990	5 44	1.24	16,459	10,161	5 2	2.9	21.15	26 63	40	130	96
Blakely Mt. Dam, Lake Ouachita, AR	307	2,104,300	690	82,373	5 24	1 53	17,144	9,524	4 3	2.8	45 39	49 31	121	139	91
Canton Lake, OK	308	3,416,500	45	19,797	5.09	1.54	17,392	10,553	4.6	3 2	32.30	22.97	95	99	74
Clearwater Lake, MO	309	888,000	27	18,715	5.43	1 38	17,943	8,456	4 0	2 7	50.51	42.24	140	192	74
Cordell Hull Dam and, Reservoir, TX	310	2,167,900	381	32,822	5 43	1 58	15,491	9,215	5 7	2.9	29.65	34.70	60	87	104
DeGray Lake, AR	311	1,659,700	207	31,800	5.17	1 58	19,235	10 612	4 8	2 7	42 04	43 42	115	164	49
Dewey Lake, KY	312	1,116,800	52	13,602	5 83	2.10	18,021	9,559	2 4	2 0	90 75	122.44	243	519	46
Fort Randall, Lake Francis Case, SD	313	4,756,000	540	133,047	5.43	1 69	20,696	11,705	3 3	3.1	100 29	93 59	260	295	50
Grapevine Lake, TX	314	5,139,100	60	17,828	5 20	1 58	19,309	10,992	6 3	2 6	38.45	64.32	92	217	92
Greers Ferry Lake, AR	315	4,407,000	276	45,548	5.15	1 15	15,890	8,562	4 7	3.0	54 16	70 00	154	306	217
Grenada Lake, MS	316	2,553,900	148	86,826	5 13	1 56	9,199	4,833	6 4	2 6	24 57	32 90	65	165	75
Hords Creek Lake, TX	317	359,500	11	3,027	5.26	1 42	16,263	9,699	4 4	3 0	39 46	48 25	108	170	54
Isabella Lake, CA	318	1,489,200	38	15,977	5.64	1 48	15,938	11,445	3 3	2 5	55 59	45 54	127	100	48
Lake Okreechobee and Waterway, FL	319	2,894,584	402	451,000	5 38	1 20	13,849	9,541	4 1	3 0	24 91	11 03	76	258	30
Lake Washington Ship Canal, WA	320	712,900	80	169	6 26	2 07	16,606	5,815	3 3	3 0	98 63	130 14	338	605	37
Leech Lake, MN	321	950,600	316	162,100	5.90	1 40	18,886	10,986	2 5	1 8	101 08	84 35	268	313	48
Melvern Lake, KS	322	2,034,600	101	24,543	5.69	1 65	18,087	9,015	4 3	3 0	31 48	29 39	84	137	45
Millwood Lake, AR	323	2,042,300	65	142,100	5 49	1 87	18,630	1,319	5.6	3 0	37 62	55.21	90	176	53
Mississippi River Pool No. 3, MN	324	1,323,700	37	20,350	6 36	2.23	29,571	10,895	3.0	2 4	99 20	79 14	196	288	49
Mississippi River Pool No. 6, MN	325	645,500	55	11,292	5.79	1 42	19,589	10,693	4 8	3 0	52 23	55.19	141	240	70
Navarro Mills Lake, TX	327	1,111,500	38	14,286	5.16	1 41	13,739	4,652	4.6	2.8	27 68	30 29	61	70	42
New Hogan Lake, CA	328	335,200	44	6,162	5 57	1.28	18,954	11,270	4.0	3.1	34.10	14.55	72	29	41
New Savannah Bluff Lock & Dam, GA	329	207,600	32	2,030	5.28	1.13	12,609	9,414	5 8	2.7	18.65	23.78	37	77	39
Norfork Lake, AR	330	3,066,500	380	54,193	5.65	1 61	17,667	8,889	3.2	2.5	94 89	59.65	268	75	42
Ozark Lake, AR	331	1,102,000	173	39,251	5.02	1 22	12,654	7,558	4 9	3.0	58 71	98.54	199	433	52
Perry Lake. KS	332	3,388,000	160	41,769	5 52	1.48	16,565	6,925	4 7	2.7	28.79	24 02	79	109	23
Philpott Lake, VA	333	1,454,900	100	9,600	5 33	1.55	14,268	6,668	5.8	2.6	25 09	46.00	47	100	38
Pine River, MN	334	1,615,100	119	22,177	5.95	1.80	20,097	9,370	2.1	1 4	69 80	50.54	178	188	75
Pokegama Lake, MN	335	948,300	53	66,542	5.70	1 45	16,816	9,476	3.3	2 7	100 63	122 30	376	590	68
Pomona Lake, KS	336	1,460,400	52	12,301	5 42	1 36	17,265	7,330	5.4	2 8	25 38	23 33	65	115	31
Proctor Lake, TX	337	975,200	27	15,956	5.49	1.63	17,510	11,167	5 4	2.9	46 08	40 96	109	103	52
Rathbun Reservoir, IA	338	2,332,200	156	36,072	5.74	1.56	20.543	7,473	4.3	2.9	41 78	29 18	96	41	31
Sam Rayburn Dam & Reservoir, TX	339	2,728,700	560	176,869	5.32	1 35	19,515	11,331	4.1	2 7	40 23	31.90	85	74	67
Sardis Lake, MS	340	2,488,900	110	98,590	5 41	1 31	13,141	7,223	6 5	2.3	36 08	42.17	123	234	205
Waco Lake, TX	343	3,371,600	60	21,342	5.46	1 25	16,396	12,454	6 9	2.2	33 02	45.10	99	263	61
Whitney Lake, TX	344	1,976,400	170	53,230	5 25	1 29	18,688	11,651	5 0	2 8	35.40	38 03	96	195	201
Youghiogheny River Lake, PA	345	1,122,600	38	4,035	5 56	1 59	16,682	11,051	5.4	2 9	24 67	9.48	47	58	31

[a] One-way distance to the site.

[b] Number of observations are based on the final models estimated for site.

NOTES: x̄ is the arithmetic mean.
σ is the standard deviation.
(T+M) cost is the sum of vehicle and time-related costs of a visit.

Lake Francis Case, South Dakota, and Sam Rayburn Dam and Reservoir, Texas, also have more than 500 miles of shoreline. Proctor Lake, Texas, and Clearwater Lake, Missouri, both have limited shorelines (27 miles). Lake Okeechobee, Florida, has the largest area of any site, 451,000 acres. At the other extreme is the Lake Washington Ship Canal which covers only 169 acres. Clearly the diverse characteristics of the Corps of Engineers sites should provide considerable range of attribute data for the generalized travel cost model. To enhance the understanding of this diversity, Chapter 4 explores several other dimensions of the site characteristics.

3.5.2 Users

Each site can be further described according to the characteristics of the users that patronize it. Users are profiled by the following variables: age and sex; household income; distance from the user's home to the site; user's cost to travel to the site; and number of visits to the site.

Table 3-3 reveals that there are considerable differences among user characteristics. The users' average household income ranges from $9,199 for Grenada, Mississippi, to $29,571 for Mississippi River Pool No. 3, in Minnesota. This could be expected, given the locations of the sites and the activities popular there. Grenada Lake is in a relatively low-income rural area. Higher-income recreators from Memphis tend to use more convenient lakes, such as Sardis and Arkabutla, Mississippi. Alternatively, Mississippi River Pool No. 3 includes part of the St. Croix River. This site, well developed with numerous yacht clubs and private marinas, is convenient to the Minneapolis-St. Paul area.

The mean income of a site's users appears to be closely related to the income level of nearby population centers. For example, the mean income of users at Lock and Dam No. 2 of the Arkansas River System, Sardis Lake, and New Savannah Bluff, is low ($10,409, $13,141, and $12,609, respectively) and these sites are close to rural areas with lower-than-average income levels. Users of sites such as Benbrook, Whitney, and Grapevine Lakes in Texas, which are near urban areas, have slightly higher incomes.

The extent of repeat visits varies depending on the average length of a stay. Sites receiving heavy day use are visited more frequently. Benbrook Lake, Grapevine and Waco, Texas, and Lock and Dam No. 2, Arkansas, all receive numerous day users, and visits per person are greater than average. Pine River and Pokegama, Minnesota, and Norfork, Arkansas, commonly draw visitors for more than a weekend, and visits per person tend to be fewer.

3.5.3 Profile of Activities at the Corps Sites

Despite its limitations, the available data on activities at the Corps sites show interesting features about the mix of activities at a site, and the data on activities indicate the range of the recreation activities. Table 3-4 summarizes the data on the most common activities: fishing, picnicking, boating, water skiing, sightseeing, hunting, and swimming. Of these, fishing and sightseeing are the most popular. An average of 38 percent of all visitors fished, while 28 percent engaged in sightseeing. Picnicking, camping, boating, and swimming seem to be of equal popularity, each averaging about 15 percent.

Fishing popularity does differ among the sites. The percentage of visitors who fished ranged from 1 percent at Lake Washington Ship Canal to 82 percent at Lake Isabella, California. Some of the differences are attributable to the nature of the site. Reservoirs without locks averaged 40 percent while those with locks averaged 28 percent. The water depth and shoreline character make Millwood Lake and Lake Okeechobee well suited for fishing. The par-

Table 3-4. Respondents' Recreational Activities, by Site

Project name	Site number	Activity: Camping (%)	Boating (%)	Fishing (%)	Swimming (%)	Walking[a] (%)	Sightseeing[b] (%)
Allegheny River System, PA	300	27	19	39	16	40	70
Arkabutla Lake, MS	301	9	14	55	31	8	35
Lock and Dam No. 2 (Arkansas River Navigation System), AR	302	52	20	83	24	NA	7
Beaver Lake, AR	303	62	36	36	70	39	65
Belton Lake, TX	304	30	47	45	53	28	50
Benbrook Lake, TX	305	31	17	42	71	31	63
Berlin Reservoir, OH	306	42	31	61	23	26	28
Blakely Mt. Dam, Lake Ouachita, AR	307	76	49	45	77	38	55
Canton Lake, OK	308	70	47	64	50	44	59
Clearwater Lake, MO	309	80	40	60	82	33	44
Cordell Hull Dam and Reservoir, TN	310	28	28	50	40	22	34
DeGray Lake, AR	311	68	48	56	70	47	70
Dewey Lake, KY	312	51	26	28	21	17	28
Ft. Randall, Lake Francis Case, SD	313	62	34	33	70	36	51
Grapevine Lake, TX	314	38	37	31	88	26	57
Greers Ferry Lake, AR	315	67	61	40	86	44	74
Grenada Lake, MS	316	19	8	59	32	NA	40
Hords Creek Lake, TX	317	75	31	42	66	47	88
Isabella Lake, CA	318	54	32	64	31	27	32
Lake Okeechobee and Waterway, FL	319	14	23	63	14	23	51
Lake Washington Ship Canal, WA	320	2	NA	2	NA	80	80
Leech Lake, MN	321	85	25	85	15	36	55
Melvern Lake, KS	322	77	38	70	55	41	45
Miliwood Lake, AR	323	29	15	82	15	22	47
Mississippi River Pool No. 3, MN	324	38	90	41	41	28	43
Mississippi River Pool No. 6, MN	325	38	54	58	55	34	47
Navarro Mills Lake, TX	327	87	43	54	63	39	83
New Hogan Lake, CA	328	61	65	49	51	25	47
New Savannah Bluff Lock & Dam, GA	329	NA	2	55	2	13	47
Norfork Lake, AR	330	63	65	56	65	35	67
Ozark Lake, AR	331	17	9	33	39	6	67
Perry Lake, KS	332	90	58	69	63	48	56
Philpott Lake, VA	333	38	43	29	88	24	45
Pine River, MN	334	90	53	56	69	79	64
Pokegama Lake, MN	335	36	5	47	8	42	67
Pomona Lake, KS	336	57	25	61	48	25	38
Proctor Lake, TN	337	75	54	65	69	50	75
Rathbun Reservoir, IO	338	95	80	67	64	39	45
Sam Ravburn Dam & Reservoir, TX	339	83	47	73		51	70
Sardis Lake, MS	340	52	31	50	44	7	33
Waco Lake, TX	343	17	30	37	53	15	41
Whitney Lake, TX	344	64	44	54	74	31	50
Youghiogheny River Lake, PA	345	53	64	44	58	42	66

Source: The 1977 Nationwide Outdoor Recreation Survey, The Heritage Conservation and Recreation Service, Department of the Interior.

NA = Activity not available at this site.

[a] Walking Includes hiking, walking, and other walking.

[b] Sightseeing includes picknicking, driving for pleasure. and sightseeing.

ticipation percentages are likely to be conservative because the surveys were usually conducted in the more developed areas, excluding the fishing in under developed areas.

Differences in site characteristics also are important in understanding the popularity of other activities across sites. For example, the hazards from the commercial navigation and the low water quality make the Lake Washington Ship Canal unsuitable for swimming and fishing. New Savannah Bluff and Arkansas River Lock Dam No. 2 discourage swimming for similar reasons, while Berlin Lake's natural character is not well suited for swimming. On the other hand, the small pool below the dam at DeGray Lake is ideal for swimming. Belton Lake, with its large open areas, is an excellent hunting location.

3.5.3.1 Fishing at the Corps Sites--

Fishing is not only a popular activity, but is also one that is clearly linked to water quality [see Vaughan and Russell (1982b)]. Because of this linkage, this section presents additional information obtained from the Corps managers about fishing at the Corps of Engineers sites.

Many species of fish are found at the sites surveyed, ranging from cold-water game fish to rough fish such as crappie or catfish. The temperatures of the water and other characteristics of the region will determine the presence of Particular species. Most of the northern reservoirs, such as Berlin, Ohio; Pokegama and Pine River, Minnesota; and Youghiogheny Lake, Pennsylvania, include coldwater game fish, such as northern or walleye. Minnesota lakes are well known for their walleye fishing. Arkansas lakes contain trout in the reservoirs' coldwater release, but they also attract fishermen after large and small mouth bass. Texas lakes are too warm for coldwater species but suitable for the common black bass and rough fish. Rough fish are present in all reservoirs. Some of the sites with poor water quality, such as Proctor and New Savannah Bluff, contain only rough fish.

Poor fish habitats are more common in rivers and older lakes than in the newer reservoirs. Rivers are subject to flow problems and effluent discharges from commercial activities. Most noticeably affected are New Savannah Bluff, Georgia, and the Arkansas and Mississippi River sites. At these, although fish are available, they are usually not of top quality. When rivers are maintained for navigation, they are dredged periodically. This damages the ecosystem, so stocking programs are generally not successful. Further, as lakes age, the bottom silts up so the natural fish-habitats degenerate. For most lakes, the best fishing is possible when the lakes are 6 to 8 years old. Several of the reservoir sites, notably Ozark, Arkansas, and Navarro Mills, Texas, are definitely past their peak in this respect.

For the 43 sampled sites, the most popular species of fish are ranked in Table 3-5. (More than one popular fish could be reported from each site.) Bass is most popular and must heavily sought at 21 sites. Catfish and crappie are frequently chosen as most popular, but usually from among fish found near the dam. When they are chosen, a second fish is usually mentioned as well. Walleye and trout are frequently listed as most popular in northern reservoirs with and without locks.

As shown in Table 3-6, coldwater fish are available at 19 sites. Mississippi, Texas, and Kansas lakes cannot support coldwater fish. Although four Arkansas lakes contain coldwater fish, several of the lakes require yearly stocking because the fish cannot reproduce in the warm climate. When coldwater game fish are available, they normally are listed as most popular.

Table 3-5. Popular Fish, by Type of Site

Kind of fish	Reservoirs without locks (N=36)	Reservoirs with locks (N=7)	Total (43 sites)
Bass	20	1	21
Catfish	15	2	17
Crappie	14	0	14
Walleye	9	3	12
Trout	6	1	7
Salmon	0	1	1
Shad	0	1	1

Source: Personal communication of RTI researchers with Corps personnel.

Note: Each site may have more than one popular fish.

Table 3-6. Sites with Cold-Water Fish, Sites with Fish-Stocking Programs, by State

State	Coldwater fish	Fish stocking programs
Arkansas	4 (9.3)	7 (16.3)
California	2 (4.7)	2 (4.7)
Kansas	0 (0)	3 (7.0)
Minnesota	5 (11.6)	4 (9.3)
Mississippi	0 (0)	3 (7.0)
Texas	0 (0)	8 (18.6)
All other States	8 (18.6)	8 (18.6)
Total sites in category	19 (44.2)	35 (81.4)
Total sites	N = 43 (100)	

Source: Personal communication of RTI researchers with Corps personnel.

Notes: Parentheses denote percentage of total sample. Column percentages may not add to total percentages due to rounding.

Fish-stocking programs are often used to augment the population of the most popular game species. Coldwater species, which tend to be most desirable, are added to fishing areas whenever the climate allows. When it doesn't, most stocking involves warmwater game fish, with the usual goal of crossbreeding bass varieties to produce better game fish.

Significant stocking programs are carried out (see Table 3-6) at 81 percent of the sample sites. Even the Minnesota and Arkansas lakes, which are favorable to several species, now require fish stocking programs due to the popularity of fishing. Several Corps lakes are used as nurseries for stocking other lakes. Ouachita, Arkansas, and Pine River, Minnesota, are used to breed game fish for nearby lakes.

3.6 SUMMARY

This chapter has summarized the data sources used to estimate the generalized travel cost model, drawn mainly from the 1977 Federal Estate Survey of visitors at 43 Corps of Engineers sites. The character of key variables--visits, travel costs, and activities--used in the model has important analytical Implications for this study. The censored and truncated dependent variable, visits, requires an ML estimator to avoid the bias in OLS estimates derived using this type of dependent variable. The travel cost measure includes both distance and time costs, the latter estimated using a hedonic wage model to predict the opportunity cost of time. Activity information is important because of its omissions: no data were available on the time allocated to each activity. This implied that any measures of activity diversity would be limited to differences across sites.

The survey procedures used to collect the data also are important: the onsite survey provided no data on either the reservation prices of nonusers or the likelihood of individuals visiting the site. The survey interviews, completed in relatively short time intervals, are likely to have minimized bias caused by visitors making multiple visits but may have increased the chance of a less representative sample of visitors for the entire year if visitors at other times of the year differ significantly.

The information on the 43 Corps of Engineers sites themselves indicate a very diverse mix of sites and activities. While they are diverse, the sites are major providers of flatwater boating and fishing, as well as extensive camping opportunities. Natural, freeflowing rivers are excluded from the sites in our sample which would suggest that these sites would be poor matches in any attempt to transfer our model’s estimates to them.

CHAPTER 4

THE U.S. ARMY CORPS OF ENGINEERS SITES

4.1 INTRODUCTION

One of the crucial requirements of the generalized travel cost model is data on the attributes of recreation sites. This chapter provides additional insights into the attributes of the 43 U.S. Army Corps of Engineers sites used in the study. It highlights the variety of their locations, physical and man-made characteristics, facilities, congestion and water quality. The chapter documents the diverse characteristics of the recreation sites that provide a foundation for the empirical estimates derived from the generalized travel cost model in Chapters 6 and 7. It also helps to develop an intuitive understanding of how the diversity of the site characteristics might affect the performance of the model. Some sites have impressively large surface areas, while others are extremely deep with very cold pools. Wildlife refuges, marinas, and even yachting facilities are found within the universe of sites. These diverse attributes provide services that can be combined with other inputs such as boating or fishing equipment and time to produce the substantial range of activities.

The chapter is divided into nine sections. Section 4.2 provides some background on Corps of Engineers policies and how they influence the site attributes and the activities undertaken at various sites. Section 4.3 describes the location of Corps sites and their relative accessibility. Section 4.4 depicts the character of the surrounding land including natural and manmade features. Section 4.5 profiles the physical characteristics of the sites ranging from pool depth to amount of available land. Section 4.6 details the range of complimentary facilities available at the various sites. Section 4.7 highlights the measurement, extent, and effect of congestion at the sites during key time periods, Section 4.8 describes the hydrological, physical, biological and chemical aspects of the sites' water quality. It also provides water quality index values for the sites. Section 4.9 concludes the chapter by summarizing its major points.

4.2 BACKGROUND

The opportunities for recreation available at the U.S. Army Corps of Engineers sites are largely byproducts of projects developed primarily for other purposes. For example, while both developed and undeveloped areas at Corps sites provide ideal conditions for such freshwater recreation activities as swimming, waterskiing, and fishing and for such complementary land-based recreation activities as picnicking, sightseeing, and camping, most sites were authorized to control one or more water-related problems--navigational difficulties, flooding, or scarcity of water for irrigation and/or water supply--or to provide electric power generating capacity or pollution control/abatement facilities.

As might be expected, the primary purpose, or purposes, of each particular project determines the configuration of the developed site. Of the 43 sites chosen for this study, 7 have dams and locks for improved navigation and reduced risk of flooding. The remaining 36 sites consist primarily of dams. The reservoirs created by these dams slow the water and retain it for one or more of the following primary purposes: irrigation, water-supply, power generation, pollution abatement, or flood control.

For each project, Corps management determines the mix of facilities to be provided and the parameters of water control. These decisions are constrained by the stated primary purpose of the project. Consequently, management decisions on primary purposes can affect recreation activities around the reservoir.

For example, when flood control requires that water levels be changed, this is done--regardless of any adverse effects on recreational use. In addition, Corps management of water levels and flow rates also affects the basic nature of the reservoir or rivers including their water quality ecosystems. Because in-stream recreation, like fishing and swimming, is sensitive to water quality, Corps policies aimed at the primary objective can inadvertently affect recreation activities. Such basic decisions about the function of a site determine its potential for recreation. For example, when river pools are developed as a result of the Corps' concern for commercial navigation, typically, the river is straightened, and facilities and access to the water are changed. In other cases, dredging operations to maintain river channels affect water quality and, thus, the site's suitability for certain water-based activities.

The Corps projects are unevenly distributed across the United States. Many are located in the South, but there are important exceptions to this general rule, especially in the upper Mississippi area. The type of project usually corresponds to a region's particular problems. As a result, different types of Corps recreation sites are clustered in areas with particular kinds of water-related problems. Thus, areas in Minnesota and Arkansas (with navigational needs) have dams with locks to assist the movement of boats on the river. The need for flood control in other parts of Arkansas and Mississippi has resulted in the development of dams and reservoirs. In both cases, a wide variety of water-oriented activities are possible in the reservoirs and surrounding lands that make up the Corps sites.

Land acquisition policies also affect the nature of the Corps sites. The Corps has purchased land for water projects under a three different land acquisition policies to date. These policies determined the amount of land the

Corps was allowed to purchase for each site. (Since development time for Corps projects usually extends over many years, it was necessary to determine the appropriate policy period for some projects. For this study, the year the project was to be completed determined the applicable policy period.) Prior to 1953, all lands deemed necessary for the project were acquired, and acquisition was determined individually for each site. From 1953 to 1962, land could be acquired only to the elevation that would hold floodwaters in an average 5-year period, not to maximum pool size. Under the third policy, effective from 1962 to the present, enough land to hold the full pool could be acquired. In all cases, land needed for access and operation was also purchased. Most of the existing Corps sites were purchased under the first policy; the remaining purchases were divided between the second policy and the present policy. Leech Lake, Minnesota, is the only site that includes land purchased under more than one policy.

The 1953-1962 land-acquisition policy has resulted in the most serious problems. Sites developed during this middle period have less land for recreation development, and the land that is available is frequently subject to flooding. Also, private developments, such as housing subdivisions, are often near the shoreline. These developments cause occasional water quality problems and limit the Corps' ability to control or improve lake access.

4.3 LOCATION OF U.S. ARMY CORPS OF ENGINEERS SITES

Participation in a site's recreational activities is influenced not only by the site's attributes but also by the characteristics of the larger area within which it is located. These attributes may include elements of its geography, topography, and history. This section considers two dimensions of the location attribute: the population density of the surrounding area, and the type of roadway available as an indication of access to the site.

4.3.1 Population Density of Surrounding Areas

Although the Corps of Engineers sites are located across a wide range of river basins, several generalizations about location can be drawn. The extensive land requirements dictate that reservoirs from Corps dams without locks are not close to large population centers. Within the sample of 43 sites, excluding those with locks, the smallest of the manmade reservoirs (Hords Creek) covers 3,027 acres and the largest (Lake Okeechobee) 451,000 acres. In addition, reservoirs usually are located in a river's sparsely populated and mountainous headwaters so that runoff from the mountains can be collected and water flow can be controlled over the length of the river. Examples of these sites include Beaver and Norfork Lakes in Arkansas, Isabella and New Hogan Lakes in California, and Philpott Lake in Virginia. Thus, the combination of hydrologic complexities and land availability determines locations of many of these sites.

One way to assess location differences among sites is to evaluate the proximity of the nearest standard metropolitan statistical area (SMSA). The data in Table 4-1 show that 36 of the 43 sites are within 60 miles of an SMSA. This information is somewhat deceiving because of the influence of the sites with locks and dams. When these are excluded, the average distance to an SMSA increases. Dams with locks tend to be near population centers, typically older cities situated on the rivers that are primarily used for navigation. Only Lake Francis Case, South Dakota, was more than 90 miles away from an SMSA, and of the 43 sites, 13 are located within 60 miles of two SMSAs. The size of nearby SMSAs varies from 84,000 persons for Lock and Dam No. 2,

Table 4-1. Distance of Sites to Nearest SMSA, Frequency by Ranges

Distance range (miles)	Sites without locks	Sites with locks	Total
0 to 24	14 (32.6)	3 (7.0)	17 (39.5)
25 to 59	15 (34.9)	4 (9.3)	19 (44.2)
60 and above	7 (16.3)	0 (0)	7 (16.3)
Total	36 (83.7)	7 (16.3)	43 (100.0)

Source: Recreation-Resource Management System, U.S. Army Corps of Engineers, Civil Works.

Notes: Parentheses denote percentage of total sample. Row and column percentages may not add to 100 due to rounding.

SMSA indicates standard metropolitan statistical area, a group of urban counties considered as a unit.

Arkansas, to 2.3 million persons for the sites located near Dallas, Fort Worth, and St. Louis. The average population of the nearest SMSA for all sites is 646,000.

Some noticeable exceptions to the above generalizations can be found. Waco Lake and the Lake Washington Ship Canal are within boundaries of large metropolitan areas. Waco Lake is in Waco, Texas, with a population of more than 147,000, and Lake Washington Ship Canal is in Seattle, Washington, with an SMSA population of 1.4 million.

4.3.2 Access by Type of Road

Access to all Corps sites in the travel cost study is over primary State roads, which, in most cases, lead directly to the dam. Table 4-2 shows the frequency of sites in four distance-ranges from an interstate. The actual mileage from a site to the nearest interstate is included in Table 4-3. At five sites, interstate highways are located less than 2 miles from the reservoir, and all but nine of the 43 sites are within 50 miles of an interstate. Leech Lake, Minnesota, 112 miles from an interstate and Norfork Lake, Arkansas, at 102 miles between reservoir and interstate were the farthest away. Note also that sites with locks are typically closer to interstate roads with 4 of the 7 within 10 miles. Convenient access to these sites has a positive influence on their use for recreation. Locks and dams, which also are more convenient to population centers, are feasible for less than a full day or day trips.

Finally, describing access by type of road is not without problems because information on the roads actually traveled by recreationists is lacking. Simplified measures, such as those in Table 4-2, may be misleading. These measures are based on an assumed road-use pattern for users from one partic-

Table 4-2. Distance of Sites to Nearest Interstate Highway, Frequency by Ranges

Distance range (miles)	Sites without locks	Sites with locks	Total
0 to 10	10 (23.3)	4 (9.3)	14 (32.6)
10 to 25	9 (20.9)	1 (2.3)	10 (23.3)
25 to 50	9 (20.9)	1 (2.3)	10 (23.3)
50 and above	8 (18.6)	1 (2.3)	9 (20.9)
Total	36 (83.7)	7 (16.3)	43 (100.0)

Source: Recreation Resource Management System, U.S. Corps of Engineers, Civil Works.

Notes: Parentheses denote percentage of total sample. Row and column percentages may not add to 100 due to rounding.

Table 4-3. Characteristics of Sites

Project name	Site number	Distance to nearest SMSA[a] (road miles)	Population of nearest SMSA[a] in 1978 (thousands)	Distance to nearest interstate Highway (road miles)	Recreation days[b] (thousands)	Length of shoreline (miles)	Site area (thousands of acres)	
							Total	Water
Allegheny River System, PA	300	35	2,401	2.0	13	20	1.1	1.1
Arkabutla Lake, MS	301	25	834	7.2	2,012	134	52.6	11.2
Lock and Dam No. 2 (Arkansas River Navigation System), AR	302	26	84	64.4	343	96	32.4	10.6
Beaver Lake, AR	303	c	145	53.2	4,883	449	40.5	28.2
Belton Lake, TX	304	c	150	12.5	2,507	136	30.8	12.3
Benbrook Lake, TX	305	c	2,377	7.5	1,978	37	11.3	3.3
Berlin Reservoir, OH	306	c	679	7.2	1,179	70	8.0	3.6
Blakely Mt. Dam, Lake Ouachita, AR	307	26	362	29.7	2,104	690	82.4	40.1
Canton Lake, OK	308	43	698	40.0	3,417	45	19.8	7.0
Clearwater Lake, MO	309	65	2,367	67.2	888	27	18.7	1.6
Cordell Hull Dam and Reservoir, TN	310	49	699	4.8	2,168	381	32.8	12.0
DeGray Lake, AR	311	53	153	2.0	1,660	207	31.8	13.4
Dewey Lake, KY	312	59	287	49.4	1,117	52	13.6	1.1
Ft. Randall, Lake Francis Case, SD	313	130	95	52.2	4,756	540	133.0	80.0
Grapevine Lake, TX	314	c	2,619	0.1	5,139	60	17.8	7.4
Greers Ferry Lake, AR	315	40	1,837	29.7	4,407	276	45.5	31.5
Grenada Lake, MS	316	90	834	3.2	2,554	148	86.8	34.3
Hords Creek Lake, TX	317	34	122	47.5	360	11	3.0	0.5
Isabella Lake, CA	318	c	373	27.3	1,489	38	16.0	6.5
Lake Okeechobee and Waterway, FL	319	40	557	22.2	2,895	402	451.0	451.0
Lake Washington Ship Canal, WA	320	c	1,421	0.1	713	80	0.2	0.1
Leech Lake, MN	321	71	264	112.0	951	316	162.1	125.9
Melvern Lake, KS	322	35	180	7.2	2,035	101	24.5	6.9

(continued)

Table 4-3 (continued)

Project name	Site number	Distance to nearest SMSA[a] (road miles)	Population of nearest SMSA[a] in 1978 (thousands)	Distance to nearest interstate highway (road miles)	Recreation days[b] (thousands)	Length of shoreline (miles)	Site area (thousands of acres)	
							Total	Water
Millwood Lake, AR	323	28	112	13.3	2,042	65	142.1	29.5
Mississippi River Pool No. 3, MN	324	c	1,997	28.0	1,324	37	20.4	18.0
Mississippi River Pool No. 6, MN	325	26	90	8.4	646	55	11.3	8.9
Navarro Mills Lake, TX	327	15	147	20.0	1,112	38	14.3	5.1
New Hogan Lake, CA	328	12	290	23.0	335	44	6.2	3.1
New Savannah Bluff Lock & Dam, GA	329	c	276	16.2	208	32	2.0	0.1
Norfork Lake, AR	330	55	187	102.3	3,067	380	54.2	22.0
Ozark Lake, AR	331	c	172	2.0	1,102	173	39.3	10.6
Perry Lake, KS	332	c	180	14.4	3,388	160	41.8	12.2
Philpott Lake, VA	333	27	723	41.6	1,455	100	9.6	2.9
Pine River, MN	334	63	157	85.4	1,615	119	22.2	13.6
Pokegama Lake, MN	335	30	264	72.8	948	53	66.5	15.9
Pomona Lake, KS	336	22	180	18.0	1,460	52	12.3	4.0
Proctor Lake, TN	337	80	2,378	30.0	975	27	76.0	4.6
Rathbun Reservoir, IA	338	50	314	462	2,332	156	36.1	11.0
Sam Rayburn Dam & Reservoir, TX	339	65	344	70.0	2,729	560	176.9	114.2
Sardis Lake, MS	340	45	834	8.0	2,489	110	98.6	31.0
Waco Lake, TX	343	c	147	0.1	3,372	60	21.3	7.3
Whitney Lake, TX	344	15	147	15.0	1,976	170	53.2	23.6
Youghiogheny River Lake, PA	345	c	263	23.0	1,123	38	4.0	2.8

Source: Recreation-Resource Management System (RRMS) U.S. Army Corps of Engineers, Civil Works.

[a] SMSA: Standard Metropolitan Statistical Areas, a group of populous contiguous areas considered as a unit.

[b] Recreation day = a visit by one individual to a development for all or part of a 24-hour period.

[c] Site located within or on the border of an SMSA.

ular direction. Because users come from all directions and use various roads, these data should be interpreted with some caution.

4.4 SURROUNDING LAND CHARACTERISTICS

The characteristics of land surrounding the sites can be discussed in terms of natural and manmade attributes. The use of a site may be positively or negatively related to the site attributes, and this relationship will vary in direction and magnitude depending on the activity and attribute considered, as well as the individual, the time period, and the level of other attributes. Nonetheless, some useful distinctions among sites can be drawn based on differences in physical characteristics.

4.4.1 Natural Characteristics

The 43 Corps sites were classified according to their natural surroundings as either forested or mountainous. In all cases, the water bodies are considered scenic attractions. Table 4-4 shows the frequency of forested and mountainous sites. Most sites fit easily into one of these categories, however, problems occurred when the recreational area and the characteristics of the surrounding region did not match--for example, when the region tended to be flat or nonforested and the site did not reflect this terrain. In these instances the site was classified according to its own characteristics, and not those of the surrounding areas. As a result, information about Perry Lake, Kansas, Rathbun Lake, Iowa, and Grapevine Lake, Texas, may be somewhat puzzling. These sites are distinctly different from the region surrounding them, which may contribute to their appeal.

Scenic attributes among States can be compared further based on Table 4-4. Both Kansas and Texas have several sites in areas that are neither forested nor mountainous. Alternatively, all Arkansas and Minnesota sites are

Table 4-4. Scenic Descriptors of All Sites, Frequency by State

State	Neither forested nor mountainous	forested or mountainous	Both forested and mountainous	Total
Arkansas	0 (0)	3 (7.0)	5 (11.6)	8 (18.6)
California	0 (0)	0 (0)	2 (4.7)	2 (4.7)
Kansas	2 (4.7)	0 (0)	1 (2.3)	3 (7.0)
Minnesota	0 (0)	3 (7.0)	2 (4.7)	5 (11.6)
Mississippi	0 (0)	2 (4.7)	1 (2.3)	3 (7.0)
Texas	5 (11.6)	2 (4.7)	2 (24.7)	9 (20.9)
All other States	5 (11.6)	3 (7.0)	5 (11.6)	13 (30.2)
Total	12 (27.9)	13 (30.2)	18 (41.9)	43 (100.0)

Source: Personal communication of RTI researchers with Corps personnel.

Notes: Parentheses denote percentage of total sample. Row and column percentages may not add to 100 due to rounding.

considered to be both in forested and mountainous areas. In both States, these attributes are considered normal for the areas and very scenic. The attributes in Table 4-4 also suggest the capability of sites to provide certain kinds of activities. For example, mountainous areas produce deeper lakes and provide a habitat for particular kinds of fish. Forested areas permit different types of hunting and hiking than nonforested areas.

In several cases, States have designated scenic roadways within Corps recreation areas. All of these roadways traverse forested or mountainous areas, but a consistent definition of a scenic roadway was impossible. Several States, such as Mississippi and Arkansas, use this designation more frequently and differently than others.

4.4.2 Manmade Characteristics

Manmade characteristics include historical occurrences, tourist areas, or commercial facilities. Historical or manmade attributes were considered important at 17 reservoirs. Old frontier or river towns, a variety of historical occurrences, and memorialized elements of earlier times (e.g., Indian burial grounds and pioneer trails) are tourist attractions. Commercial facilities occur at all 43 sites in the form of private marinas or commercial navigation. Private marinas typically rent facilities on Corps land. Usually, two or three marinas are located at a reservoir. However, several sites, such as Lake Ouachita, Arkansas, and Pokegama Lake, Minnesota, are extensively developed and have many marinas.

Commercial navigation is present at all dams with locks, as well as at Lake Okeechobee, Florida, and Lake Ouachita, Arkansas. At most of these sites, the transportation of products is the only large commercial activity. However, several sites, such as Lake Ouachita and the Arkansas River Lock and Dam

No. 2, Arkansas, and Mississippi River Pool No. 6, Minnesota, support a noticeable level of commercial fishing.

The dam itself is also considered an important manmade entity. Distinctions among locks and dams for navigation, low-head dams, and dams for large reservoirs may be important when identifying recreation potential. The larger dams for reservoirs are more popular for sightseeing, apparently because of the unobstructed view they offer. However, even low-head dams and locks attract many visitors who enjoy watching commercial navigation or the flow of water.

Power-generating capability also contributes to recreation potential. People are attracted by tours of the power-generated facilities. The dams that produce hydroelectric power are those at Sam Rayburn Reservoir and Whitney Lake, Texas; Ozark Lake, Greers Ferry Lake, and Lake Ouachita, Arkansas; Cordell Hull Reservoir, Tennessee; and Lake Francis Case, South Dakota. In all cases, the electric power produced is sold to the surrounding community.

4.5 PHYSICAL CHARACTERISTICS

The physical descriptions of the 43 Corps sites are based on data from the Corp’s Recreation Resource Management System. Measures of physical characteristics, such as size of land and water areas, length of river and shoreline, depth of the lake, and size of the dam are available for most sites. Understanding these characteristics may also help to explain differences in the production of activities.

One of the important variables is the size of the water surface. Size affects the number and kinds of possible activities at a site and was frequently cited as crucial to the quality of a site. Large lakes, such as Lake Okeechobee, Florida, and Leech Lake, Minnesota, are used heavily for a variety of activities. Their large surface areas also limit congestion. Alternatively, activities at dams with locks tend to be limited due to the size of their reservoirs. For example, Mississippi River Pool No. 3 and Arkansas River Lock and Dam No. 2 experience congestion because their water and land areas are small relative to the demand.

Table 4-5 shows a significant range in pool size, as measured by acres of water surface. Reservoirs with locks are normally smaller. In part, this is because those with locks are located in areas where flooding is more controllable. The largest water surface behind a dam with a lock is less than 20,000 acres, while 12 dams without locks have lakes with a water surface of 20,000 acres or more.

The amount of available land, another important variable, affects the potential for nonwater-based activities. For example, Philpott Lake, Virginia, Whitney Lake, Texas, and Rathbun Lake, Iowa, all have large grounds for hunting and hiking. Most other lakes have extensive camping and picnicking areas. However, calculations based on the reported acres of land may be misleading. Only Corps-owned land is presented in Tables 4-3 and 4-6, but several sites contain many private developments that provide land for nonwater-based activity. Lakes such as Leech and Pine River, Minnesota, and Okeechobee, Florida, are notable examples. As a result, the amount of land actually available for recreation can be much larger than the figures suggest.

Pool depth affects both water quality and the availability of some activities. Water quality is affected because deep lakes thermally stratify, have lower levels of dissolved oxygen, and are less turbid. Deeper lakes also exhibit a greater variety of fish habitat because species can occupy different temperature levels. Acitivities such as scuba diving, waterskiing, and swim-

Table 4-5. Size of Land and Water Surfaces at Sites, by Frequency and Ranges (acres)

	Total site area		Water surface		Land areas	
Size ranges	Sites without locks	Sites with locks	Sites without locks	Sites with locks	Sites without locks	Sites with locks
0 to 4,999	2 (4.7)	3 (7.0)	10 (23.3)	3 (7.0)	5 (11.6)	5 (11.6)
5,000 to 9,999	3 (7.0)	0 (0)	6 (14.0)	1 (2.3)	6 (14.0)	0 (0)
10,000 to 14,999	4 (9.3)	1 (2.3)	7 (16.3)	2 (4.7)	7 (16.3)	0 (0)
15,000 to 19,999	5 (11.6)	0 (0)	1 (2.3)	1 (2.3)	4 (9.3)	0 (0)
20,000 to 29,999	3 (7.0)	1 (2.3)	4 (9.3)	0 (0)	4 (9.3)	2 (4.7)
30,000 to 39,999	4 (9.3)	2 (4.7)	3 (7.0)	0 (0)	2 (4.7)	0 (0)
40,000 to 49,999	3 (7.0)	0 (0)	1 (2.3)	0 (0)	2 (4.7)	0 (0)
50,000 to 59,999	3 (7.0)	0 (0)	0 (0)	0 (0)	3 (7.0)	0 (0)
60,000 to 99,999	4 (9.3)	0 (0)	1 (2.3)	0 (0)	2 (4.7)	0 (0)
100,000 and above	5 (11.6)	0 (0)	3 (7.0)	0 (0)	1 (2.3)	0 (0)
Total	36 (83.7)	7 (16.3)	36 (83.7)	7 (16.3)	36 (83.7)	7 (16.3)

Source: Recreation Resource Management System, U.S. Army Corps of Engineers, Civil Works.

Notes: Parentheses denote percentage of total sample. Total percentage may not add to 100 due to rounding.

Table 4-6. Water-Level Variation During Peak Recreation Period, by Range and Site Types

Range of change (feet)	Reservoirs without locks (frequency)	Reservoirs with locks (frequency)	Total (frequency)
0 to 9	5 (15.6)	4 (12.5)	9 (28.1)
10 to 19	1 (3.1)	2 (6.3)	3 (0)
20 to 29	4 (12.5)	0 (0)	4 (12.5)
30 to 39	9 (28.1)	0 (0)	9 (28.1)
40 to 50	7 (21.9)	0 (0)	7 (21.9)
Total	26 (81.3)	6 (18.8)	32 (100.0)

Source: Recreation Resource Management System, U.S. Army Corps of Engineers, Civic Works.

Notes: Parentheses denote percentage of total sample. Column percentage may not add to 100 due to rounding.

ming are more attractive in deeper lakes. Of the sample sites, three are noticeably deeper than the others. Isabella Lake, Whitney Lake, and Youghiogheny Lake were all described as deep and attractive for scuba diving, water skiing, and fishing.

Although the available data on pool depth are not consistent, a reasonable proxy may be the amount of fluctuation in lake levels. Table 4-6 shows fluctuation from minimum to maximum pool levels during peak recreation periods. As expected, locks and dams tend to be stable, while reservoirs may vary by as much as 40 to 50 feet. Note that these measures do not describe frequency or central tendencies; only limits are recorded. In addition, lakes differ in their ability to assimilate damages caused by changing lake levels that cannot be easily determined.

In addition to the preceding physical characteristics that are common to all sites, other attributes may affect a particular activity. For example, Philpott Lake has secluded shorelines that are good for fishing. Certain reservoirs, such as Isabella, have straight and accessible shorelines that make good swimming beaches.

Other uncommon characteristics can affect activity on the lakes. For example, in portions of Lock and Dam No. 2, Arkansas, levees produce calm water, which makes this area popular for waterskiing. At Lake Okeechobee. and Millwood Lake, boat lanes are regularly cleared of growth by the Corps. Several lakes are popular for characteristics that are unique to the area Whitney Lake, Texas, is deep, with well-established shade trees and large bluffs. Canton Lake, Oklahoma, has rolling hills and forested areas.

It is important to recognize that seasonal variations can affect the measurement of physical characteristics. Most noticeable is the relationship between water level and the satisfaction derived from recreation. Other examples include the effect of seasonal variations in available shoreline, vegetation, and water quality. Simple statistics cannot always describe a site adequately. In addition, data on some physical attributes are more representative when measured daily. Consequently, the estimation of any relationship between site characteristics and demand parameters will be quite difficult. As noted earlier, our measures of site characteristics, as well as our understanding of how they influence recreational activities is at this stage limited.

4.6 FACILITIES

Facilities at Corps sites are provided by Federal, State, and local agencies. Prior to 1960, new facilities were paid for solely by the Corps. Since then, all costs of new recreation facilities must be shared by the State involved. Of the 43 sample sites, 17 were built after 1960. Consequently, some newer sites, in States with less active recreation policies, have a relative shortage of facilities. Policies on land acquisition, management, and actual facilities available are discussed in the next subsections.

4.6.1 Facilities and Management Practices

The particular governmental agency that controls recreational land near a reservoir will determine the quantity and the type of development allowed at a site. Each area can be designed for either low-level or intensive recreation use. With as much as 98 percent of its land used for intensive recreation, Corps lands are at least as developed as are those of other government agencies. Federal, State, and local agencies have also developed on Corps sites. However, the maximum total land developed for intensive recreation by any one of these groups is 13 percent. Private groups have also developed areas for intensive use with a maximum of 4 percent of total land available developed in the group of 43 sites.

The kinds of facilities at a site are also influenced by the presence of other government agencies. The Corps tends to provide facilities for common activities, such as swimming, boating, fishing, and camping. Other government agencies may increase the range of activities by providing for low-level-use areas (e.g., wildlife refuges) and additional intensive-use areas (e.g., outdoor pools or overnight lodges). Wildlife preservation areas are commonly managed by States. Local agencies frequently provide such areas as town swimming pools or day-use facilities. Private groups, such as the Girl Scouts and 4-H Clubs, provide facilities to meet their goals, but these facilities are not open to the general public. In these cases, actual land ownership is retained by the Corps and the land necessary for the facilities is made available under a long-term lease.

4.6.2 Availability of Facilities at Corps Sites

Corps policy states that a reservoir should provide as many activities as possible. Corps sites without locks are consistent in the number and kinds of facilities provided. Facilities for picnicking, camping, hiking, fishing, and swimming are most often provided. The management decisions that control these facilities are also consistent among sites. However, reservoirs with locks tend to vary in the types of facilities provided. Poor water quality and commercial boat traffic limit some recreation activities, and the available space is usually limited to a narrow flood control waterfront.

All of the sample sites maintain day-use facilities, which include picnic and water-access areas. (Swimming beaches are provided only when water quality and safety allow.) The degree of development depends on existing natural conditions. At sites with poor natural swimming areas, for example, sand may be added or the shoreline leveled.

All Corps sites, except Mississippi River Pool No. 3 and Lake Washington Ship Canal, have primitive or developed camping facilities. Of the 41 sites, 14 offer areas for primitive camping in which campers are not required to use designated campsites. Undeveloped roads, trails, and waterways are the only means of access, and campers are responsible for maintaining the primitive environment of the areas. Developed camping, available at all 41 sites, usually includes electrical hookups for campers and paved access roads.

Several interesting differences exist among the sites. Whitney Lake, Texas, has a severe shortage of developed camping facilities. Lake Ouachita, Arkansas, has primitive camp sites on an island, accessible only by boat. The campsites at Pine River, Minnesota, are more desirable than local private resorts, so campers are frequently turned away because the site is full.

Fishing facilities depend on fish populations and natural access. Several sites, such as New Savannah Bluff, Georgia, and Proctor Lake, Texas, are not popular for fishing, so facilities are minimal. At several other lakes, natural access is considered adequate, so manmade facilities are also minimal. However, a majority of the sites provide fishing docks or ramps, placed above and below the dam.

4.6.3 Nontypical Facilities

Although basic facilities are homogeneous at the sites studied, several sites have additional, nontypical facilities. Lake Washington Ship Canal has a botanical garden and an area where fish can be seen from below the water level. At several lakes, Ouachita, Arkansas, and Pokegama, Minnesota, for example, public marinas have been extensively developed. Dewey Lake, Kentucky, has resort-like facilities, with a restaurant, cabins, outdoor pool, and a chairlift for sightseeing. Other unusual facilities include scuba diving areas, educational nature trails, golf courses, outdoor pools, and a kayaking course.

4.7 CONGESTION

Causes and effects of congestion or crowding of recreation areas are diverse. Consideration of congestion involves its causes, its spatial and temporal dimensions, the differing perceptions of it, and the varying importance of congestion to the recreationist.

In addition, solutions to congestion are limited by Corps policy. Sites are equipped and managed to allow open access for as many activities as possible; limiting the users in an area is not considered a solution. Moreover, a majority of sites could not limit entry because of their numerous access points.

4.7.1 Measurement of Congestion

Congestion was measured at each of the 43 sites during particular time periods. Corps managers ranked their entire site by level of congestion (very congested, somewhat congested, or not congested at all) during three time periods: (1) holidays--Memorial Day, the 4th of July, and Labor Day; (2) weekends, during the year; and (3) weekdays from June through October. The managers also were asked how this rating varied among the different recreation areas within each site and what activities were involved. Managers were willing to rank an area by the choices given, and they readily stated the specific problems encountered at each site.

4.7.2 Time Periods

At most of the 43 sites, congestion occurred during holiday periods but not on weekdays. As shown in Table 4-7, 59.5 percent of all sites are considered “very congested” during summer holidays, compared to 2.4 percent on

Table 4-7. Sites with Congestion, by Period of Time and Level of Congestion

Level of congestion	Congestion over summer holidays (frequency)	Congestion on weekends (frequency)	Congestion on weekends (frequency)
Very congested	25 (59.5)	13 (31.0)	1 (2.4)
Somewhat congested	14 (33.3)	15 (35.7)	6 (14.3)
Not congested at all	3 (7.1)	14 (33.3)	35 (83.3)
Total	42 (100)	42 (100)	42 (100)

Source: Personal communication of RTI researchers with Corps personnel.

Notes: Parentheses denote percentage of total sample. Column percentages may not add to 100 due to rounding.

weekdays. Three sites were listed as never congested on summer holidays, Lake Francis Case, South Dakota, Cordell Hull Dam and Reservoir, Tennessee, and Lake Okeechobee, Florida. In these areas the lack of crowding was probably because of their nonurban locations and the large amounts of space available for recreation.

Weekend congestion was the most difficult to summarize because use varies throughout the year. For example, most Texas lakes are very congested during spring weekends and not at all during August. Alternatively, Lake Washington Ship Canal is congested during summer weekends and less so at other times. Although weekday use usually does not result in congestion, seven sites did report weekday congestion. This heavy weekday use was caused either by campers staying more than a weekend or by day users spending an afternoon.

The difference in congestion over the three time periods was related to the site's distance from large population centers. Sites close to heavily populated areas are heavily used on weekdays. At Benbrook, Grapevine, and Waco Lakes, Texas, users visit the site for a few hours. However, to visit the majority of the 43 sample sites, 30 to 60 minutes of driving is required. At these sites, heavy weekend and holiday use occurs, and weekday congestion is minor. At sites that require extensive travel, users typically stay longer than a weekend. Consequently, lakes such as Pine River, Minnesota, and Norfork, Arkansas, experience congestion during all three time periods.

4.7.3 Spatial Considerations of Congestion

Within a site, congestion often varies from one recreational area to another. In most of the 43 sites, the potential for congestion increases when the area offers developed camping, swimming pools, or manmade beaches.

Also, several areas were congested because they provide convenient access to the water. In addition, congestion is more apparent near dams, perhaps because dam areas are well developed, scenic, and the water just above the dam is deeper than elsewhere.

4.7.4 Activities and Congestion

The activities most affected by congestion are boating, waterskiing, fishing, camping, or any day-use. The affected activities can be divided into water-based and land-based.

Most water-based problems result from heavy usage and inadequate reservoir surface area. At sites such as Beaver Lake, Arkansas, Berlin Reservoir, Ohio, and Youghiogheny Lake, Pennsylvania, pleasure boating, waterskiing, and fishing almost constantly interfere with each other. However, large lakes such as Lake Francis Case, South Dakota, Lake Okeechobee, Florida, and Leech Lake, Minnesota, do not experience congestion even when use becomes heavy, as it does occasionally. Several average-size lakes do not experience Congestion, even with heavy use. At Clearwater Lake, Missouri, waterskiing lanes are specifically designated. At other lakes, such as Philpott, Virginia, the natural attributes of the site separate users; for example, a shoreline may have natural inlets or water depth may preclude an activity. This holds true at Lake Sardis, Mississippi, and Lake Sam Rayburn, Texas. At Perry Lake, fishermen tend to come on weekdays and waterskiiers on weekends.

Lake access problems, usually caused by a scarcity of boat ramps, occur at 10 sites. Either the ramps are scarce relative to the number of persons who want to put their boats in the water, or the ramps are used for activities, like swimming or fishing, for which they were not intended. Other common access problems stem from a lack of sufficient shoreline for swimming or picnicking.

Away from the lakes, land-based congestion is related primarily to parking shortages, noise, and insufficient camping and day-use space. Such problems are encountered more frequently in well-developed areas, such as the dam site and the areas that are also State parks.

At nine sites, activities by day users and campers occasionally conflict. At times, these two groups compete for facilities and lake access. For example, day users travel through campsites en route to the lakes at Grapevine, Texas, and Berlin, Ohio. To control this, several sites have separated these two groups of users by designating a section of the site as a park where camping facilities can be used by permit or fee only.

4.8 WATER QUALITY

Water quality is an important characteristic of the Army Corps sites considered here. However, it is difficult to define water quality in a way that allows valid comparisons among sites. This one characteristic contains many components. Some are correlated to the attributes of the sites; some are related to the requirements of the recreationist. Some can be measured scientifically, while others can only be assessed subjectively. Many of the parameters in this study--including some of each kind--are considered in this section as are water quality problems that affect particular sites.

All 43 Corps sites are freshwater systems. Such systems can be classified either as lentic systems, which contain standing waters (e.g., lakes), or as lotic systems, which contain running waters (e.g., rivers). Although nutrient cycles are alike, physical attributes, life cycles, assimilative capacity, and causal relationships differ between the two systems. However, because all of the 43 sites have manmade impoundments, none fails clearly into one or the other category.

A system's ability to accommodate recreation may be defined by a series of hydrological, physical, chemical, and biological parameters. Both relative and absolute levels of these variables are important in describing existing conditions. Synergistic effects are also important but difficult to describe. Individual parameters and overall measures of water quality through indexes are discussed in the following subsections. Table 4-8 lists the annual mean value of parameters thought to be important to recreation at the sample sites. These data are from the various agencies reporting to the USGS WATSTORE system. For sites that had several monitoring stations, an average was used.

4.8.1 Hydrological Parameters

The atmosphere and catchment area of a site can be characterized by hydrological parameters. These measure properties of atmosphere, precipitation, erosion, and vegetation. These parameters are important characteristics for this study because they can directly influence both recreation and the levels of other parameters. Given the geographical distribution of the 43 sites, each site has a unique set of such characteristics. However, because of data limitations, only a qualitative discussion is possible.

Climate is one of the most important hydrological parameters. Variations in climate can affect the activities supported by a site. For example, Lake Washington has long rainy seasons, Texas lakes simmer in hot summers, and Minnesota sites freeze up during cold winters; the activities enjoyed in each site reflect these differences. Several areas such as those in Arkansas and California experience few extremes of temperature or moisture. The net result of climatic fluctuations is usually a variation in the intensity of activity at certain times of the year.

In addition, changes in climate cause changes in travel patterns. Texas lakes, which are popular in spring, are too hot for summer use. During this period, the recreationists go elsewhere, traveling north to Arkansas sites to avoid the heat. Minnesota sites attract vacationers in the summer who go elsewhere in winter. In addition, those who use the sites are influenced by characteristics of the catchment area.

Catchment areas differ depending on land use and terrain. The importance of these differences will be discussed in the next few sections. Canton, Oklahoma, Francis Case, South Dakota, and Perry and Pomona, Kansas, all of which are in farmland areas, are subject to pesticide pollution carried in runoff water. Okeechobee, Florida, is in a low-lying marsh area that floods and receives loadings of nutrients from local dairies. The waters behind the dams with locks are subject to industrial and urban effluents as well as to large fluctuations in flow. Except for the sites mentioned above, most reservoirs are in mountainous or hilly terrain. Although this usually means clearer water, it also means that lake levels can vary greatly with the season, thus influencing use of the site for recreation purposes.

4.8.2 Physical Parameters

Physical parameters, including turbidity, color, temperature, odor, and taste, are well-known measures of water quality. Often, these characteristics result in clearly recognizable conditions and will therefore influence the attractiveness of sites for recreation purposes. The measures may vary significantly from place to place within a site. In addition, variations may be caused by season, time of day, water depth, and water flow. While all these parameters are important, only turbidity and temperature will be discussed here because of data limitations.

Turbidity, the presence of suspended solids, may be caused by manmade or natural occurrences. It can be measured in two ways. A Sechi disc indicates the transparency of water by the distance (below the surface) at which it disappears from view. Alternatively, Jackson turbidity units (JTU) are obtained by a scope placed in the water. Both measures--where available--are presented for each site in Table 4-8.

Turbidity influences water quality in several ways. A system's biological productivity depends on the amount of incoming sunlight, and material suspended in the water filters, or blocks, the sunshine. Turbidity can significantly reduce recreational value by limiting the growth of lake vegetation, which provides food and protection for fish. At several sites, high turbidity is a problem. At Dewey Lake, Kentucky, for example, turbidity is caused by fine silt, generated by local mining operations, that is washed into the lake. Because these solids are so lightweight, they remain suspended for long periods. As shown in Table 4-8, Benbrook Lake, Texas, and Arkansas River Lock and Dam No. 2, Arkansas, were also high in turbidity. Although measures are not available, the water at other dams with locks can also be expected to be turbid. In these cases, the water movement prevents the solids from settling. However, for the most part, Corps reservoirs without locks contain clear water--so clear that it is common to find sites with Sechi disk readings of 3 to 4 feet.

Temperature is a major determinant of biological and chemical activity in water. It can influence algae growth, fish populations, physiological responses in swimmers, and the general satisfaction derived from water-based activities. Several aspects of the 43 Corps sites determine water temperature. The most

Table 4-8. Mean Water Quality Parameters and Index Values, for June through September, by Site

Project name	Site number	Temper-ature (°C)	pH	Dissolved oxygen (saturation percent)	BOD_5	Turbidity (JTU)	Fecal coliform (per 100 mL)	Sechi disk (inches)	Index RFF	Index NSF
Allegheny River System, PA	300	23	7.4	90	NA	NA	NA	NA	6.66	64.33
Arkabutla Lake, MS	301	NA	8.1	NA	NA	NA	NA	NA	6.48	63.35
Lock and Dam No. 2 (Arkansas River Navigation System), AR	302	18	7.7	92	2.5	50	230	NA	6.04	64.69
Beaver Lake, AR	303	12	7.5	NA	5.2	11	25	NA	6.74	60.39
Belton Lake, TX	304	21	7.9	66	NA	NA	NA	56	6.66	68.95
Benbrook Lake, TX	305	20	7.7	98	2.4	63	189	NA	4.26	38.87
Berlin Reservoir, OH	306	20	7.2	55	2.4	16	2	31	7.71	57.76
Blakely Mt. Dam, Lake Ouachita, AR	307	16	6.9	93	2.2	7	46	NA	8.10	78.24
Canton Lake, OK	308	16	8.0	101	NA	14	NA	NA	7.10	71.83
Clear-water Lake, MO	309	17	7.7	NA	8.2	NA	NA	47	6.05	57.43
Cordell Hull Dam and Reservoir, TN	310	15	7.2	92	2.1	11	20	34	7.96	76.79
DeGray Lake, AR	311	NA	NA	NA	NA	NA	NA	NA	6.66	64.33
Dewey Lake, KY	312	NA	NA	NA	NA	NA	NA	NA	6.66	64.33
Ft. Randall, Lake Francis Case, SD	313	7	7.6	NA	NA	NA	NA	NA	6.66	65.41
Grapevine Lake, TX	314	17	7.8	94	17.0	40	16	NA	5.77	49.65
Greers Ferry Lake, AR	315	17	6.9		7.8	8	79	NA	6.23	60.41
Grenada Lake, MS	316	NA	NA	NA	NA	NA	NA	NA	6.66	64.33
Hords Creek Lake, TX	317	19	7.9	90	NA	NA	7	NA	7.99	70.91
Isabella Lake, CA	318	17	7.5	95	NA	4	NA	43	7.46	65.61
Lake Okeechobee and Waterway, FL	319	26	8.3	94	1.3	16	3	37	8.51	74.41
Lake Washington Ship Canal, WA	320	15	7.6	98	NA	2	14	NA	7.92	76.89
Leech Lake, MN	321	7	7.9	NA	2.0	0	0	NA	8.60	82.63

(continued)

Table 4-8 (continued)

Project name	Site number	Temper-ature (°C)	pH	Dissolved oxygen (saturation percent)	BOD_5	Turbidity (JTU)	Fecal coliform (per 100 mL)	Sechi disk (inches)	Index RFF	Index NSF
Melvern Lake, KS	322	24	7.8	86	15.0	6	6	41	6.93	52.35
Millwood Lake, AR	323	21	7.5	103	NA	NA	NA	NA	7.21	73.55
Mississippi River Pool No. 3, MN	324	11	7.9	87	3.8	17	227	NA	6.44	65.88
Mississippi River Pool No. 6, MN	325	12	8.0	97	NA	8	151	NA	6.55	68.53
Navarro Mills Lake, TX	327	22	7.6	NA	NA	NA	NA	NA	6.66	64.78
New Hogan Lake, CA	328	21	7.8	100	13	1	NA	50	6.37	51.18
New Savannah Bluff Lock & Dam, GA	329	NA	NA	NA	NA	NA	NA	NA	6.66	64.33
Norfork Lake, AR	330	12	7.8	148	4	3	43	NA	7.32	71.72
Ozark Lake, AR	331	NA	NA	NA	NA	NA	NA	NA	6.66	64.33
Perry Lake, KS	332	24	8.3	98	17	6	10	32	6.57	56.15
Philpott Lake, VA	333	18	9.1	NA	NA	NA	NA	NA	3.73	45.43
Pine River, MN	334	NA	7.7	NA	2	0	0	NA	8.60	82.70
Pokegama Lake, MN	335	NA	7.7	NA	NA	0	0	NA	8.14	78.02
Pomona Lake, KS	336	22	7.9	34	NA	21	33	18	7.33	55.54
Proctor Lake, TN	337	23	7.6	NA	NA	NA	NA	NA	6.66	61.65
Rathbun Reservoir, IO	336	23	7.7	90	20	14	NA	28	5.49	49.33
Sam Rayburn Dam & Reservoir, TX	339	19	6.8	78	1	NA	NA	77	7.28	74.15
Sardis Lake, MS	340	NA	NA	NA	NA	NA	NA	NA	6.66	64.33
Waco Lake, TX	343	NA	NA	NA	NA	NA	NA	NA	6.66	68.95
Whitney Lake, TX	344	NA	NA	NA	NA	NA	NA	NA	6.66	64.33
Youghiogheny River Lake, PA	345	16	6.9	NA	8	3	NA	NA	6.34	48.54

Source: U.S. Department of the Interior, 1983, National Water Quality Data Exchange, U.S. Geological Survey.

NA = Not available.
BOD_5 = Biological oxygen demand for 5 days
JTU = Jackson Turbidity Units
RFF = Resources for the Future
NSF = National Sanitation Foundation

important factors are geographical location of the sites, the depth of the lake, and the design of the impoundment.

Because the sites are located in different parts of the country, temperatures of their waters vary widely (Table 4-8). But most of the sites reported average temperatures in the range of 15° to 23° C. The Minnesota sites, along with Norfork, Arkansas, were noticeably colder, and Lake Okeechobee, Florida, was much warmer. In response to these different temperature ranges, the mix of activities varies from site to site.

A site's physical characteristics can also influence the water temperature. Two important characteristics are the depth of the water and the depth in relation to the surface area. Deep lakes with relatively small surface areas tend to experience temperature stratification. In them, the water levels differ in temperature and amount of dissolved oxygen. Dissolved oxygen in the upper levels does not mix with that in the lower levels. In the deeper water, lack of dissolved oxygen causes vegetable and animal life to decay. So large amounts of nutrients become stored at lower levels, while in the upper levels, dissolved oxygen remains high.

During the spring and fall, sunshine and air temperature affect the temperature of the upper water. Temperature differentials lessen, and dissolved oxygen mixes with the nutrients. This process leads to algae blooms, which again decay, often creating a distinctive odor.

Although the process of mixing occurs twice a year, the summer stratification has a greater impact on recreation. Stratification may not be so extreme in winter in locations where the temperatures do not fall significantly. However, in certain areas, the level of dissolved oxygen at the bottom of the lake is near zero. These eutrophic conditions have additional implications for water quality, including the mixing of phosphate with heavy metals.

Most of the reservoirs are monitored for stratification. Several of the 43 lakes experience stratification. The more significant problems occur at Berlin, Ohio, and Youghiogheny, Pennsylvania. One exception is Lake Okeechobee, which, because it is shallow, mixes year round.

A third factor that influences water temperature (in this case, temperature below the dam) is the design of the dam structure. Most sites draw water through intake towers set at one level. As a result, spillway water varies in temperature depending upon the season. Several sites have the ability to draw water at various lake levels and, therefore, can maintain a certain water temperature downstream. Usually this temperature control maintains the necessary habitat of cold-water fish.

4.8.3 Chemical Parameters

Water can also be described by its chemical components, natural and man-made. This section discusses dissolved oxygen, acidity (pH), nitrogen compounds, metals, and complex organics. Samples are often taken where effluents are expected, and, as a result, chemical measures of water quality may be biased since they do not necessarily describe a representative sample.

Dissolved oxygen is frequently measured for several reasons. It indicates the ability of a system to perform aerobic decomposition. Low levels of dissolved oxygen permit anaerobic decomposition, which has an offensive odor. Further, many fish species cannot survive or reproduce in water with low levels of dissolved oxygen. Controlled experiments have related fish reproduction to levels of dissolved oxygen. The level of dissolved oxygen is increased by photosynthesis and the mixing of atmospheric oxygen and surface water. Decreases are primarily caused by decomposition processes.

Several sites reported incidences of low levels of dissolved oxygen. Berlin Lake, Ohio, Lake Sam Rayburn, Texas, and Mississippi River Pool No. 3, Minnesota, have had low readings, probably because of upstream effluent discharges by industry and municipalities. For the remaining sites, dissolved oxygen was relatively good. Fish populations were not affected in any way, nor was anaerobic decomposition ever apparent.

The acidic-basic relationships of mineral substances are measured along a pH scale of 1 to 14. Under natural conditions, pH may range from 5.0 to 8.6. Changes within this pH range may affect a system, often causing a decrease in the population of a variety of organisms, including fish. In addition, recreationists may experience eye irritation if pH falls outside the 6.5 to 8.3 range. All of the sites measured fall within a narrow pH range. The main concern is low pH (acid conditions), which is most likely to occur in cool areas when flow is low. For example, Dewey Lake has pH problems.

Nitrogen compounds in various combinations can also affect water quality. Nitrates are formed by the biochemical oxidation of ammonia. In areas with livestock nearby, high levels of nitrates are a concern. They cause algae blooms and subsequent pungent-smelling decay. Among the sites, only Lake Okeechobee, which has dairies nearby, was directly affected by this problem. Areas near farmlands are indirectly affected by fertilizer runoff, which feeds nitrogen compounds into lakes and streams.

The presence of metals can affect users who come in direct water contact and inhibit fish population. Metals usually settle to the bottom of a water system and are not a direct problem. However, these compounds (or elements) do not decompose and may build up in the food chain. Industry effluents and urban runoff are the main causes of heavy metal pollution. Hence, rivers such as the Mississippi, Allegheny, and Arkansas are of concern. Dredging on the Mississippi was the only problem explicitly considered. In this instance, metals on the bottom were stirred up and in some cases placed on the shorelines.

Pesticides and surface active agents are manmade compounds. Both of these compounds destroy plant and animal life and tend to build up in the higher levels of the food chain. The variety of sources make conclusions on expected levels difficult. Urban areas and farmlands are responsible for the introduction of these compounds.

4.8.4 Biological Parameters

Biological parameters give a reliable estimate of the quality, size, and type of animal and plant population in a system. These parameters measure the presence of organisms that do not readily adapt to change. Frequently, the parameters are expressed as an average for some period of time.

Biological oxygen demand (BOD) is a commonly reported measure that indicates the rate of oxygen consumption owing to organic decomposition. High levels of BOD are detrimental when combined with low levels of dissolved oxygen. Sites such as Melvern Lake, Kansas, and Lake Rathbun, Iowa, experience this situation. Alternatively, sites such as New Hogan, California, Perry, Kansas, and Rayburn, Texas, all experience high levels of BOD and high levels of dissolved oxygen. Conclusions on damage to water quality are difficult to draw in these cases.

Microbiological parameters measure the possibility of waterborne disease. Most common is a fecal coliform reading to test for bacteria introduced by animal feces. All of the 43 sites were considered safe in regard to this problem. The only exceptions were Mississippi River Pool No. 3, Minnesota, and Arkansas River Lock and Dam No. 2. The higher readings at these sites are caused by municipal sewage treatment plants. Other sites with higher readings than the sample average were Benbrook, Texas, Greer Ferry, Arkansas, and Mississippi River Pool No. 6, Minnesota.

Algae growth is another measure of microbiological activity. Except at high levels, algae are not toxic but rather indicate overfertilization of the system by man or other mammals. Algae is a visible and wide nuisance. Most sites experience some type of algae growth. Lake Okeechobee, Florida, and Lake Millwood, Arkansas, the only sites that have taken preventive measures, have sprayed and introduced algae-eating fish.

4.8.5 Index Values

The use of individual parameters as a measure of water quality does not account for synergistic effects. The parameters also suggest different implications for the overall level of water quality. In addition, the match of people's perceptions of the quality of the water and parameter values may also differ among the parameters. Finally it may be more convenient for reporting purposes, or policy formulation, to have a summary water quality indicator that reflects the overall water quality. In combination, these factors have led to the development of water quality indexes.

Two important water-quality indexes have been developed. To determine its index, the National Sanitation Foundation (NSF) uses a composite of nine parameters, a rating of quality for each parameter, and a series of weights. These variables were rated as important in surveys of water-quality specialists. Parameters chosen include dissolved oxygen, fecal coliform, pH, BOD, turbidity, nitrates, phosphates, temperature, and total solids. Table 4-8 shows the NSF index values in the form of

$$\prod_{i=1}^{q} q_i^{w_i} \qquad , \tag{4.1}$$

where

q_i = the quality rating arraigned to the i^{th} parameter

W_i = weight.

The NSF index was calculated for each of the 43 sites. Values ranged from a low of 38.87 for Benbrook Lake, Texas, to a high of 82.70 for Pokegama Lake, Minnesota. The index appears to perform well on expected water-quality matched-index values. Some exceptions may be the higher-than-expected rating assigned to Mississippi River Pools No. 2 and No. 6, Arkansas River Lock and Dam No. 2, and Sam Rayburn Lake, Texas.

The Resources for the Future (RFF) index is based upon the NSF index. Index values are created from the first five NSF parameters and are related to the uses allowed at the sites. A range of values of 0 to 10 with 5 use-designations are possible. Except for one site, all were above the 5.1 value needed to be acceptable for game fishing. Philpott Lake, Virginia, has a value of 3.73, an index value that indicates water quality acceptable only for boating. This is puzzling because the discussions with Corps personnel suggested the lake has no problem with manmade effluents and is a high-quality fishing lake. Leech, Pokegama, and Pine Lakes in Minnesota, and Ouachita Lake, Arkansas, all had good water-quality ratings, as expected. The remaining sites were within the 5.7 to 7.0 range.

4.9 SUMMARY

All sites used in the travel cost model are described in this chapter. In addition, variables considered important to an individual's decision concerning recreation trips are presented. Consequently, this information should provide ideas concerning how to model the role of site characteristics for recreation decisions.

Several important conclusions can be drawn. First, distance from an SMSA, length of stay, and activities appear interrelated. Sites close to large populated areas tend to be used throughout the week. Most of the sites used required some driving, and use is normally for a weekend or at least a full day. Other sites that require more than an hour of driving tend to draw visitors for longer than a weekend. Activities also are linked to how far people are willing to travel. Sites that are unique in offering some activity draw users from a larger than average radius. These unique activities are generally caused by attributes such as deep water, scenery, or good fish habitat.

Availability of facilities is also related to the participation of State and local agencies. Several sites are well-developed owing to the incorporation of State and local parks. In several cases, this development takes the form of campgrounds and outdoor pools; in others, wildlife areas are maintained. In all cases, the facilities provided widen the scope or quality of activities at the site.

Congestion varies among sites and time periods. Several sites are never congested, even in peak use periods; others are always congested. For the most part, congestion is noticeably worse during summer holidays rather than on weekdays. When congestion occurs, most activities are affected.

The water quality levels were generally of comparable magnitudes across the 43 sites with all sites having water-quality levels capable of supporting game fishing. When other complementary attributes--for example, the hydro-geologic makeup, character of the shoreline, or the presence of a coldwater gamefish stocking program--are combined with the water quality, the setting for top level gamefishing is ideal.

In conclusion, the 43 Corps of Engineers sites exhibit a substantial range of attributes that are important to providing water-based recreation. The attributes include both manmade and natural physical characteristics, complementary recreation facilities, and reasonably good water quality levels. Exactly how important any of these attributes are for the generalized travel cost model is an empirical question to be answered in subsequent chapters.

CHAPTER 5

THE REPRESENTATIVENESS OF THE DATA

5.1 INTRODUCTION

The ultimate usefulness of the estimated benefits for improved water quality and of the effects of specific recreation activities on those estimates will hinge on the quality of the data used in models that generate them. The two previous chapters have described the data on the U.S. Army Corps of Engineers sites that represent the universe of the data to be used in developing the empirical results. The logical question to be asked is how representative are these data of all water-based recreation.

This chapter explores two dimensions of the representativeness question: its demand side and its supply side. The demand side investigation compares users of Corps sites with other recreationists on Federal Estate lands and with all U.S. recreationists. To appraise the supply side, we compare the mix of recreation activities supported by a Corps of Engineers site with activity mixes of an extensive sample of water-based recreation sites in the United States. This sample includes both Federal Estate lands and State parks. The data used in the supply side comparison are adapted to obtain a very rough appraisal of the number of water-based sites that are potential substitutes for the Corps of Engineers sites used in the empirical analysis. In this admittedly crude effort, three sites illustrate the problems imposed by the lack of data on actual substitutes considered by the recreationists. An alternative approach to the substitute site problem is presented in the concluding section of this chapter.

Specifically, Section 5.2 compares the characteristics of users to appraise the demand side. Section 5.3 discusses the basis for comparing the supply side, Section 5.4 compares the activities on water-based Federal Estate lands, and Section 5.5 covers the State recreation areas. Section 5.6 provides the illustrative appraisal of substitution opportunities for the sites. Section 5.7 concludes the chapter with a summary of its main points.

5.2 COMPARISONS OF USER CHARACTERISTICS

Tables 5-1 through 5-5 provide comparisons of the sample of users for the Corps of Engineers sites with a national sample of recreationists and a sample of recreationists from other Federal Estate Lands (see Chapter 3 for details of the data). These tables include selected demographic variables: race, age, education, occupation, and location of residence.

Compare, first, the sample of recreationists at Corps of Engineers sites to the sample drawn from the general public. The tables show that recreationists at Corps sites--

- are more likely to be Caucasian: Caucasians make up 95 percent of visitors to Corps recreation sites, but only 86 percent of the general public.

- are less likely to be over age 65: Only 6 percent of recreationists at Corps sites, as compared to 14 percent of the general public, are over 65. Recreationists at Corps sites are more heavily concentrated in the 25-34 age group (24 percent) and the 35-44 age group (19 percent) than is the general public (21 percent and 12 percent, respectively).

- are only slightly better educated: Nearly the only difference between recreationists at Corps sites and the general public with respect to education is that 3 percent more of the former hold college degrees.

- are more likely to be employed as craftsmen, foremen, and laborers; are less likely to be clerical workers, retired, or unemployed: The last two conclusions probably stem from the reduced financial resources of the retired and unemployed. Note in Table 5-4 that the proportions of professionals and

Table 5-1. Race of Survey Respondents

Sample	Race						
	Caucasian	Black	Mexican	Puerto Rican	Indian	Canadian	Other
	Percent						
General public	86	11	1	<.5	<.5	0	1
Recreators on Federal Estate	95	2	1	<.5	<.5	0	1
Recreators at Corps of Engineers sites	95	3	<.5	0	<.5	0	1

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 3. Washington, D. C.: Government Printing Office, 1979.

Table 5-2. Age of Survey Respondents

Sample	Age						
	12-17	18-24	25-34	35-44	45-54	55-64	≧65
	Percent						
General public	12	15	21	12	15	10	14
Recreators on Federal Estate	10	18	25	19	13	9	6
Recreators at Corps of Engineers Sites	11	17	24	19	13	10	6

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 3. Washington, D. C.: Government Printing Office, 1979.

Table 5-3. Education of Survey Respondents

Sample	Highest level of education completed: Elementary school	Jr. High school	High school	College	Graduate school
	Percent				
General public	4	11	59	21	5
Recreators on Federal Estate	2	6	48	33	11
Recreators at Corps of Engineers sites	4	8	60	24	4

Source: U.S. Department of the interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 3. Washington, D. C.: Government Printing Office, 1979.

Table 5-4. Occupation of Survey Respondents

Sample	Occupation 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Percent														
General public	12	2	5	9	3	9	3	6	3	13	15	5	17	<.5	<.5
Recreators on Federal Estate	21	1	7	5	3	10	4	5	3	8	15	2	15	<.5	<.5
Recreators at Corps of Engineers sites	13	2	7	5	4	12	5	6	6	8	13	2	17	<.5	<.5

Key:

1. Professional, technical, and kindred workers
2. Farmers
3. Managers, officials, and proprietors
4. Clerical and kindred workers
5. Sales workers
6. Craftsmen, foremen, and kindred workers
7. Operatives and kindred workers
8. Services workers
9. Laborers, except farm and mine
10. Retired, widowed
11. Student
12. Unemployed, on relief, laid off
13. Housewife
14. Other
15. Occupation not reported

SOURCE: U.S. Department of the Interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 3. Washington, D.C.: Government Printing Office, 1979.

Table 5-5. Residence of Survey Respondents

Population	Location of residence		
	Urban	Suburban	Rural
	Percent		
General public	33	36	30
Recreators on Federal Estate	33	39	28
Recreations at Corps of Engineers sites	34	30	36

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 3. Washington, D.C.: Government Printing Office, 1979.

technical workers are about the same for recreationists at Corps sites and the general public.

- are more likely to be rural: Thirty-six percent of Corps recreationists live in rural areas vs. 30 percent of the general public. The proportion living in urban areas is about equal in the two samples. Thus, the suburban portion of the general public is under represented at Corps sites.

How representative are recreationists at Corps sites of the recreationists at federally owned sites in general? Tables 5-1 through 5-5 indicate that, compared to recreationists on the Federal Estate as a whole, recreationists at Corps sites--

- are less educated: High school is the highest educational level completed by 60 percent of the Corps recreationists but by only 48 percent of all Federal Estate recreationists. Fewer recreationists at Corps sites hold college degrees (24 percent vs. 33 percent) or graduate degrees (4 percent vs. 11 percent).

- are more likely to be employed as craftsmen, foremen, or laborers; are much less likely to be professionals or technical workers: Only 13 percent of Corps recreationists belong to the professional class, as compared to 21 percent of recreationists at all Federal sites.

- are more likely to be rural: Rural dwellers are overrepresented (and suburban dwellers are underrepresented) among Corps recreationists as compared to both the general public and recreationists at all federally owned sites.

Recreationists at Corps sites accurately represent the race and age distributions of recreationists on the entire Federal Estate.

Usually income is an important argument of an ordinary demand equation. However, its empirical performance in recreation demand studies is considerably more mixed [see Smith, Desvousges, and McGivney, 1983]. As reported in Table 5-6, the middle and upper-middle income classes are overrepresented in the Corps sample as compared to the general public. Twenty-five percent of the Corps sample (vs. 18 percent of the general public) report income in the

Table 5-6. Income of Survey Respondents

Sample	<$6,000	$6,000-$10,000	$10,001-$15,000	$15,001-$25,000	$25,001-$50,000	>$50,000	Not reported
	Percent						
General public	18	23	18	23	9	2	7
Recreators on Federal Estate	7	13	23	34	16	3	4
Recreators at Corps of Engineers sites	9	16	25	32	11	2	5

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 3. Washington, D.C.: Government Printing Office, 1979.

$10,000 to $15,000 bracket, 32 percent (vs. 23 percent) report income in the $15,000 to $25,000 bracket, and 11 percent (vs. 9 percent) fall in the $25,000 to $50,000 bracket. Compared to recreationists on the Federal Estate as a whole, recreationists at Corps sites have slightly lower incomes. A higher percentage of Corps recreationists (16 percent vs. 13 percent) report incomes of $6,000 to $10,000. Eleven percent report incomes in the $25,000 to $50,000 bracket, compared to 16 percent in the sample of recreationists at all Federal sites. Note, however, that the Corps sample tracks the Federal Estate sample more closely than it does the general public sample. Thus, differences in income between users of Corps sites and users of the Federal Estate appear to be small.

Tables 5-7 and 5-8 contain information that may be interpreted as directly reflecting tastes for recreation. Table 5-7 indicates, not surprisingly, that recreationists, whether at Corps sites or elsewhere on the Federal Estate, view recreation as more important than does the general public. The table reporting Participation in recreation activities in the year previous to the survey (Table 5-8) reveals the distribution of individuals' preferences among different recreation outputs. Among the general public, for example, picnicking apparently yields utility to many people (23 percent participated in 1976) but skateboarding does not (less than 0.5 percent participated in 1976). Alternatively, participation in a specific recreation activity between one and four times in the past year may be viewed as a signal that the participant has attained some minimum level of skill in performing--i.e., producing--that activity. Thus, a larger percentage of the general public exhibits at least minimal skill in the production of camping in a developed area than in the production of waterskiing (18 percent vs. 8 percent). Table 5-8 also shows that, for most recreation

Table 5-7. Importance of Recreation to Survey Respondents

Sample	Importance of recreation: Very important	Somewhat important	Not very important
	Percent		
General public	57	29	13
Recreators on Federal Estate	80	17	3
Recreators at Corps of Engineers sites	81	17	2

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 3. Washington, D.C.: Government Printing Office, 1979.

Table 5-8. Participation Between One and Four Times in Recreation Activities in Past Year

Recreation activity	Sample: General public	Sample: Recreators on Federal Estate	Sample: Recreators at Corps of Engineers sites
	Percent		
Camping, developed	18	23	22
Camping, primitive	12	12	8
Canoeing, etc.	11	10	7
Sailing	6	5	3
Water skiing	8	9	11
Fishing	17	17	16
Other boating	14	13	13
Outdoor pool swimming	14	9	6
Other outdoor swimming	11	14	13
Nature walks, etc.	14	15	11
Hiking, backpacking	12	14	9
Walking, jogging	11	10	7
Bicycling	8	9	7
Horseback riding	7	7	5
Offroad vehicles	6	7	5
Hunting	5	6	6
Picnicking	23	21	19
Golf	5	4	3
Outdoor tennis	9	6	5
Cross-country skiing	1	2	1
Downhill skiing	3	5	2
Ice skating	7	5	3
Sledding	9	6	4
Snowmobiles	3	3	2
Other outdoor sports	13	7	6
Sightseeing	26	19	15

(continued)

Table 5-8 (continued)

Recreation activity	General public	Recreators on Federal Estate	Recreators at Corps of Engineers sites
	Percent		
Pleasure driving	12	14	11
Zoos, fairs, etc.	34	23	18
Attending outdoor sports	17	14	10
Attending outdoor concerts	19	13	10
Hang gliding	<.5	1	1
Parachute jumping	<.5	<.5	<.5
Rock climbing	<.5	<.5	<.5
Gardening	<.5	<.5	<.5
Exercise	<†5	<.5	0
Scuba diving	<.5	0	0
Surfing	0	<.5	<.5
Skate boarding	<.5	<.5	<-5

Source: U.S. Department of the Interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 3. Washington, D.C.: Government Printing Office, 1979.

activities, the differences in participation between Corps recreationists and the general public and between Corps recreationists and Federal Estate recreationists are not large. One notable exception is that sightseers and patrons of zoos, fairs, outdoor sports events, and concerts are under-represented among Corps recreationists as compared to both the general public and Federal Estate recreationists as a whole.

The remaining two tables compare responses by Corps recreationists and Federal Estate recreationists to selected questions from the Federal Estate Survey. There is a greater proportion of frequent users among Corps recreationists than among Federal Estate recreationists, as shown in Table 5-9. Forty-one percent of Corps recreationists, compared to 25 percent of the Federal Estate recreationists, visited the site more than five times in the 12 months preceding the survey. Frequency of use, or experience with the site, may affect the site-demand equation by influencing the individual's efficiency in producing particular recreation activities.

Table 5-10 indicates that recreationists at Corps sites generally spent less time traveling to the site than did Federal Estate recreationists. Forty-seven percent of Corps recreationists, compared to 31 percent of Federal Estate recreationists, traveled less than 1 hour to the site. Only 7 percent of the Corps recreationists, compared to 25 percent, traveled over 8 hours to the site. If the opportunity cost of time is the same for the two groups, then this component of travel cost is generally lower for Corps recreationists than for Federal Estate recreationists.* If distance and travel time are closely cor-

*Since Corps recreationists are somewhat more concentrated in the lower income brackets than Federal Estate recreationists, Corps recreationists' opportunity cost of time may also be lower. This observation strengthens the conclusion in the text.

Table 5-9. Frequency of Visits to Site

Sample	Number of trips to site last year: 0	1-2 times	3-5 times	>5 times
	Percent			
Recreators on Federal Estate	45	19	11	25
Recreators at Corps of Engineers sites	25	19	15	41

SOURCE: U.S. Department of the Interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 5. Washington, D.C.: Government Printing Office, 1979.

Table 5-10. Travel Time to Site

Sample	Travel time to site: 0-1 hr	Up to 2 hrs	Up to 4 hrs	Up to 8 hrs	>8 hrs
	Percent				
Recreators on Federal Estate	31	16	14	14	25
Recreators at Corps of Engineers sites	47	23	14	9	7

SOURCE: U.S. Department of the interior, Heritage Conservation and Recreation Service. The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 5. Washington, D.C.: Government Printing Office, 1979.

related, then out-of-pocket travel expenses are also generally lower for Corps recreationists.

5.3 THE SUPPLY SIDE OF RECREATION: A BASIS FOR COMPARING SITES

The preceding sections compared the characteristics of individuals who used Corps recreation sites (demanders) to characteristics of broader groups of individuals. This section focuses on the basis for comparing the features of the Corps sites as a group to other Federal sites and to State recreation areas.*

The Corps sites are compared to other recreation areas largely on the basis of activities pursued at the sites. Ideally, one would like to compare directly the attributes of two sites or groups of sites--e.g., number and condition of boat ramps, picnic shelters, tennis courts, restrooms, trailer hook-ups; water quality; size of parking areas; and congestion at various times during the season. However, this detailed information is not readily available for most recreation sites. Instead, it is necessary to infer something about a site's facilities and attributes from the activities recreationists pursue there. For example, availability of nonpool swimming requires that water of sufficient quality be available for swimming. If motorboating is reported at a site, boat launching ramps must be present. For other activities, however, the corres-

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*The low-quality information on privately owned recreation areas prevented their inclusion in this comparison. One source of information on recreation facilities in the private sector is a 1977 report by the National Association of Conservation Districts titled Inventory of Private Recreation Facilities. It reports for various recreation activities both the number of establishments that supply the activity and the total number of specific facilities associated with the activity that are available. For example, the number of enterprises supplying vacation camping and the total number of camping vehicle and tent sites available are reported. The data are reported and arranged by State. After reviewing this report, it was omitted from further consideration because of unreliable information. For example, 54,254 holes of regulation golf at 244 private establishments are reported in Florida, for an average of over 12 18-hole courses per establishment.

pondence between facility or attribute and activity is not fixed.* A picnic, for example, may be enjoyed at a picnic table beneath a shelter or on a blanket under a tree; picnicking does not require picnic tables or shelters. This caveat applies to all the comparisons that follow.

The most outstanding characteristic shared by Corps recreation sites is that they are based on reservoirs or other bodies of water and offer some combination of boating, fishing, swimming, and waterskiing. A criterion is needed to identify other sites that also share this basic characteristic. In this report, a water-based recreation area is defined to be a site that supports at least two of the following three water-based activities: boating (motor or nonmotor), nonpool swimming, and fishing. This definition of water-based recreation and recreation sites is admittedly limited. For example, camping along a river may be considered water based if the river increases the enjoyment of the campers. However, the information required to judge whether a water body is important or incidental to recreationists is simply not available. Thus, this definition of water-based sites excludes many sites that are water based in the broadest sense, but it does identify sites where--as at 45 of the 46 sample Corps sites--the water body is of primary importance to recreationists.

Chapter 3 presents detailed information on participation in selected non-water-based activities at the sample Corps sites (see Table 3-4). For purposes of the comparison, the highlights are presented here. Of the activities, fishing, boating, picnicking, and camping are the most widely available and the most popular. For example, recreationists picnic at all Corps sites with an av-

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*This is important because of the theoretical restrictions imposed on the model in order to develop a consistent relationship between the aggregate (across activities) site demand and the demands resulting from each activity (see Chapter 2).

erage participation rate of 39 percent. Camping facilities are available at 98 percent of the sites, and an average of 55 percent of recreationists camp while onsite. Nature walks, sightseeing, and hiking are pursued at the great majority of Corps sites but by fewer recreationists. Average participation is 20 percent for nature walks, 14 percent for sightseeing, and 8 percent for hiking.

5.4 ACTIVITIES ON WATER-BASED FEDERAL ESTATE LANDS

Given the preceding profile of the Corps sites as a group, this section explores whether the sample Corps sites are representative of non-Corps Federal recreation sites. If the attributes of the sample Corps sites are broadly representative, then one more condition is fulfilled for confidently extending the proposed model and results beyond the original sample. The groups of sites are compared on the basis of their water-based site classification and the availability of selected non-water-based activities.

Table 5-11 reports for each State the number of non-Corps recreation sites covered by the Federal Estate Survey that are water based. It also summarizes the availability of selected nonwater-based activities at these recreation sites. Ninety percent of the sample non-Corps recreation sites are water based, according to the definition of a water-based site employed in this chapter. These water-based Federal sites are also similar to the Corps sites in terms of the availability of other activities. Picnicking is available at 100 percent of the water-based non-Corps sites, and camping is available at 93 percent of the sites.* Nature walks and sightseeing are pursued at practically all of

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*The availability percentages for the water-based non-Corps sites were calculated by dividing the sum of the appropriate activity column in Table 5-12 by the sum of column 3 (number of water-based non-Corps sites). For example, the percent of water-based non-Corps sites taken as a group that also offer camping was computed as the sum of column 4 divided by the sum of column 3.

Table 5-11. Water-Based Non-Corps Federal Recreation Sites

State	No. of sites	No. of water-based sites	No. of water-based, non-Corps sites that also support								
			Camping	Hiking	Picnicking	Golf	Tennis	Nature walks	Sight-seeing	Riding	Hunting
AL	1	1	1	0	1	0	0	0	0	0	0
AZ	4	3	3	3	3	1	1	3	3	1	0
AR	1	1	1	1	1	0	0	1	1	0	0
CA	13	12	11	12	12	0	3	12	12	10	7
CO	7	7	7	7	7	3	3	7	7	7	2
CT	0	0	0	0	0	0	0	0	0	0	0
DE	0	0	0	0	0	0	0	0	0	0	0
FL	3	3	3	3	3	0	0	3	3	0	0
GA	2	2	2	2	2	0	0	2	2	0	0
ID	4	4	4	4	4	0	0	4	4	2	0
IL	1	1	1	1	1	0	0	1	1	0	1
IN	2	2	2	2	2	0	0	2	2	2	0
IO	0	0	0	0	0	0	0	0	0	0	0
KS	0	0	0	0	0	0	0	0	0	0	0
KY	2	2	2	2	2	2	2	2	2	2	1
LA	1	0	0	0	0	0	0	0	0	0	0
ME	1	1	1	1	1	0	1	1	1	1	0
MD	2	2	2	2	2	1	2	2	2	2	1
MA	2	1	1	1	1	1	1	1	1	1	0
MI	3	3	2	3	3	0	1	3	3	1	0
MN	1	1	1	1	1	0	0	1	1	0	0
MS	1	1	1	1	1	0	0	1	1	0	0
MO	0	0	0	0	0	0	0	0	0	0	0
MT	4	4	4	4	4	1	1	4	4	2	0

(continued)

Table 5-11 (continued)

State	No. of sites	No. of water-based sites	No. of water-based, non-Corps sites that also support								
			Camping	Hiking	Picnicking	Golf	Tennis	Nature walks	Sight-seeing	Riding	Hunting
NE	1	1	1	1	1	0	0	1	1	0	0
NV	4	4	4	4	4	1	0	4	4	2	2
NH	0	0	0	0	0	0	0	0	0	0	0
NJ	1	0	0	0	0	0	0	0	0	0	0
NM	3	3	3	3	3	1	1	3	3	3	1
NY	2	1	0	1	1	1	1	1	1	1	0
NC	3	2	2	2	2	1	1	2	2	2	0
ND	1	1	0	1	1	0	0	1	1	0	0
OH	1	1	1	1	1	1	1	1	1	1	0
OK	2	2	2	2	2	1	2	2	2	2	1
OR	6	6	6	6	6	0	0	6	6	0	0
PA	1	0	0	0	0	0	0	0	0	0	0
RI	0	0	0	0	0	0	0	0	0	0	0
SC	1	1	0	0	1	0	0	1	1	0	0
SD	1	1	1	1	1	0	0	1	1	1	0
TN	2	2	1	2	2	0	0	2	2	1	0
TX	2	1	1	1	1	1	1	1	1	1	1
UT	6	6	6	6	6	0	1	6	6	4	2
VT	1	1	1	1	1	0	0	1	1	0	0
VA	4	3	2	3	3	0	0	3	3	0	0
WA	4	3	3	3	3	0	0	3	3	2	0
WV	1	1	1	1	1	0	0	1	1	0	0
WI	1	1	1	1	1	1	0	1	1	1	0
WY	5	5	5	5	5	0	1	5	5	4	4

SOURCE: U.S. Department of the Interior, Heritage Conservation and Recreation Service. <u>The Third Nationwide Outdoor Recreation Plan: Appendix II: Survey Technical Report 5.</u> Washington, D.C.: Government Printing Office, 1979.

the non-Corps sites. Hiking trails and bridle paths are more widely available at water-based non-Corps sites (98 percent and 58 percent, respectively) than at the sample Corps sites (82 percent and 24 percent). Golf and tennis are less widely available at water-based non-Corps sites than at Corps sites. In summary, 90 percent of the sample non-Corps Federal recreation sites are similar to the sample Corps sites--first, because they are water based and, second, because picnicking and camping are available at nearly all of them. The availability of the remaining selected activities at the Corps sites is not as closely matched by the water-based non-Corps sites. However, if average participation rates in these activities are low at the non-Corps sites, as they are at the Corps sites, then these differences are probably minor.

5.5 ACTIVITIES ON WATER-BASED STATE RECREATION AREAS

This section compares the Corps site with state recreation areas. The most convenient source of information on State recreation areas is the Mobil Travel Guide set. The seven regional Guides are intended for use by vacationers and include detailed maps, basic facts about each State, and listings of accommodations and points of interest by city or town. A list of State recreation areas is included in the introductory material for each State, and many are briefly described in the main text under the heading of a nearby town. The major advantages of the Guides for collecting information about State recreation areas are that they are easily accessible and present information for the 48 contiguous States in the same format. State statistical abstracts are an example of an alternative source of data on State parks. However, it is difficult to locate statistical abstracts for all States for the same year. Each State may define recreation areas differently, and the level of detail of information and the format of the report probably vary widely from State to State.

The _Mobil Travel Guides_ are not without problems. Because they are intended for casual use by travelers, documentation is poor. for example, the _Guides_ do not define "State recreation area." Acquaintance with the _Guides_ suggests that any State land--e-g., State parks, forests, historic sites--that provide at least some developed recreation facilities (besides sight-seeing) are included as State recreation areas. This definition is not, however, spelled out in the _Guides_. Another problem with the _Guides_ is that not all recreation areas listed in the introductory text for a State are described in the city and town listings, yet the criteria used to determine whether an area is described or just listed are not reported. Finally, the information available in the _Guides_ is generally limited to lists of activities available at the sites and, less frequently, acreage figures. Additional information that would be particularly valuable for this report--e.g., water quality, age, and condition of facilities, and congestion--is not available.

Table 5-12 reports for each State the number of State recreation areas listed in the _Mobil Travel Guides_, the number described in the text of the _Guides_, and the number of described recreation areas that may be classified as water based. It also summarizes the availability of selected other activities at water-based State recreation areas. It is clear from columns 2 and 3 that the percentage of parks described varies widely among States. Only 15 percent of Connecticut's State recreation areas are described in the text, but 100 percent of the recreation areas listed for Kentucky and Tennessee are described. On average, 70 percent of a State's recreation areas are described. Given these gaps in the information about State recreation areas, how can one arrive at an estimate (for each State) of what percent of all State recreation areas are water based and, therefore, basically similar to the Corps sites?

Table 5-12. Water-Based State Recreation Areas

State	Number of State parks	Number of parks described in Guide	Number of described parks with water-based recreation	Number of described, water-based parks that also support: Camping	Hiking	Picnicking	Golf	Tennis	Nature walks	Sightseeing	Riding	Hunting
CT	47	7	3	1	0	3	0	0	0	0	0	0
ME	22	16	11	10	1	10	0	0	0	0	0	0
MA	53	14	10	8	7	7	0	0	0	2	7	7
NH	33	17	3	3	1	3	0	0	0	1	0	0
NY	75	73	49	40	25	47	8	2	11	3	4	2
RI	19	9	6	1	0	6	1	0	0	1	2	0
VT	35	27	19	18	11	16	1	0	11	2	0	0
DE	42	7	4	4	4	4	0	0	1	0	0	0
MD	41	30	10	8	5	9	0	0	2	3	0	0
NJ	32	19	12	8	0	12	0	0	2	5	0	4
NC	16	11	7	6	5	7	0	0	5	2	1	0
PA	76	37	30	23	26	29	0	0	13	2	6	25
SC	40	33	26	25	21	25	1	2	21	4	5	0
VA	14	12	11	11	8	10	0	1	2	0	4	2
WV	34	33	10	6	3	10	1	4	4	2	2	1
AL	22	19	15	10	2	15	6	4	0	1	0	0
FL	55	47	34	28	28	34	0	0	29	9	1	0
GA	36	21	16	16	6	14	1	1	5	2	0	0
KY	35	35	23	23	7	19	13	10	6	5	13	0
MS	18	14	12	12	8	10	0	5	8	1	0	1
TN	29	29	21	21	14	19	5	8	11	1	5	1
IL	71	35	24	22	12	23	0	0	2	6	8	7
IN	38	20	16	16	5	16	0	3	10	2	9	3
MI	72	34	29	26	4	25	3	1	11	4	4	13

(continued)

Table 5-12 (continued)

State	Number of State parks	Number of parks described in *Guide*	Number of described parks with water-based recreation	Number of described water-based parks that also support: Camping	Hiking	Picnicking	Golf	Tennis	Nature walks	Sightseeing	Riding	Hunting
OH	58	36	33	25	23	32	4	0	16	2	5	7
WS	51	39	32	30	12	28	1	0	7	8	3	1
AR	22	21	14	14	5	12	1	2	8	1	0	0
CO	17	13	13	12	2	11	0	0	1	0	2	0
KS	22	21	20	20	0	20	0	0	0	0	0	0
LA	11	5	4	3	0	4	0	0	0	1	0	0
MS	34	27	20	19	13	16	0	0	4	4	3	0
NM	27	23	13	13	2	13	1	1	0	0	0	0
OK	37	28	22	22	9	22	8	7	4	1	8	0
TX	57	50	30	28	1	27	1	0	1	0	0	0
ID	17	11	10	9	6	10	1	0	2	0	2	0
IO	61	52	34	29	16	33	4	0	1	0	0	0
MN	63	29	21	20	18	20	0	0	2	1	7	0
MT	26	23	17	16	1	16	0	0	0	0	0	0
NE	66	42	39	39	5	39	0	0	1	1	2	25
ND	11	6	3	3	1	3	0	0	0	0	0	1
OR	101	74	46	30	3	45	0	0	0	3	1	0
SD	26	15	13	13	1	12	1	0	0	1	1	1
WA	78	53	39	35	27	33	1	2	2	4	1	0
WY	9	8	6	6	0	5	0	0	0	0	0	1
AZ	10	9	6	6	2	6	1	1	1	1	0	0
CA	83	50	30	28	16	25	1	0	10	6	4	0
NV	19	16	6	5	1	6	0	0	0	0	0	0
UT	23	17	9	8	0	8	1	0	0	0	0	0

SOURCE: *Mobil Travel Guides, 1981*. New York: Simon and Schuster, 1981.

One approach is to assume that the percent of all parks (described and undescribed) that are water based is the same as the percent of described parks that are water based. This assumption is valid if parks receiving descriptions were not chosen on the basis of a water-based classification or of any other variable related to that classification. Table 5-13 reports these estimates, which were computed by dividing column 4 by column 3 in Table 5-12. Using these estimates, at least 50 percent of recreation areas are water based in all but six States.

A more conservative approach to estimating the percentage of all water-based State recreation areas is to ignore all parks not described in the Guides. It is risky to apply the proportion of described parks that are water based to the set of undescribed parks (as the first approach does) because the criteria used by the editors of the Guides in choosing parks for descriptions are unknown. Parks located on large bodies of water may have been specifically singled out for description. Further, it is not easy to categorize undescribed parks on the basis of name alone. For example, many of the State recreation areas in Delaware contain the word "pond" in their names. Without more information, it is difficult to determine whether a "pond" is actually a lake with boating, fishing, and waterskiing (i.e., water based) or literally a small pond with fishing from the banks but no boating or swimming. Table 5-14 presents conservative estimates of the percent of States' recreation areas that are water based, computed as

$$\begin{pmatrix}\text{\% of parks that} \\ \text{are described}\end{pmatrix} \times \begin{pmatrix}\text{\% of described parks} \\ \text{that are waterbased}\end{pmatrix}$$

The conservative estimates range from 6 percent water based in Connecticut to 90 percent in Kansas. A majority of parks are water based in 26 States

Table 5-13. Percent of State Parks that are Water Based: Estimates[a]

State	Estimate of percent of all parks that are water based	State	Estimate of percent of all parks that are water based
Connecticut	43	Ohio	92
Maine	69	Wisconsin	82
Massachusetts	71	Arkansas	67
New Hampshire	18	Colorado	100
New York	67	Kansas	95
Rhode Island	67	Louisiana	80
Vermont	70	Missouri	74
Delaware	57	New Mexico	57
Maryland	33	Oklahoma	79
New Jersey	63	Texas	60
North Carolina	64	Idaho	91
Pennsylvania	81	Iowa	65
South Carolina	79	Minnesota	72
Virginia	92	Montana	74
West Virginia	30	Nebraska	93
Alabama	79	North Dakota	50
Florida	72	Oregon	62
Georgia	76	South Dakota	87
Kentucky	66	Washington	74
Mississippi	86	Wyoming	75
Tennessee	72	Arizona	67
Illinois	69	California	60
Indiana	80	Nevada	38
Michigan	85	Utah	53

[a] Estimates are percent of described State parks that are water based.

SOURCE: Mobil Travel Guides, 1981. New York: Simon and Schuster, 1981.

Table 5-14. Percent of State Parks that are Water Based: Conservative Estimates[a]

State	Estimate of percent of all parks that are water based	State	Estimate of percent of all parks that are water based
Connecticut	6	Ohio	57
Maine	50	Wisconsin	62
Massachusetts	18	Arkansas	64
New Hampshire	9	Colorado	'76
New York	65	Kansas	90
Rhode Island	31	Louisiana	36
Vermont	54	Missouri	58
Delaware	10	New Mexico	48
Maryland	24	Oklahoma	60
New Jersey	37	Texas	53
North Carolina	44	Idaho	59
Pennsylvania	40	Iowa	55
South Carolina	66	Minnesota	33
Virginia	79	Montana	65
West Virginia	29	Nebraska	60
Alabama	68	North Dakota	28
Florida	61	Oregon	45
Georgia	44	South Dakota	50
Kentucky	66	Washington	50
Mississippi	67	Wyoming	67
Tennessee	72	Arizona	60
Illinois	34	California	36
Indiana	42	Nevada	32
Michigan	40	Utah	39

[a]Estimated as percent of all State parks that are described multiplied by the percent of described parks that are water based.

SOURCE: Mobile Travel Guides, 1981. New York: Simon and Schuster, 1981.

even using the conservative estimates, and 39 States have over 33 percent water-based parks.

On Table 5-12, the last nine columns summarize, from the Guides' descriptions, the availability of selected other activities at water-based State recreation areas. Picnicking and camping are important activities at water-based State parks, as they are at the Corps sites. Taking the (described) water-based parks of all 48 contiguous States as a group, 93 percent offer picnicking and 88 percent have camping facilities.* Hiking trails, bridle paths, hunting grounds, golf courses, and tennis courts are all less widely available at water-based State recreation areas than at Corps sites, as summarized below:

	Available at percentage of sample Corps sites	Available at percentage of water-based State parks
Hiking	82	* 42
Riding	24	12
Hunting	22	12
Golf	31	7
Tennis	40	6

Columns 10 and 11 of Table 5-12--availability of nature programs and sightseeing--are included for completeness because this information was collected from the Guides, but they may not be compared to their closest counterparts in the tables for the Corps and non-Corps Federal recreation sites because of differences in definitions. Opportunities for sightseeing are not necessarily greater at Federal sites than at State sites, as the tables imply, because in the Federal-site tables sightseeing includes such activities as gazing

*These percentages, and those that follow, were computed by dividing the sum of the appropriate activity column in Table 5-12 by the total of column 4. The percent of all water-based State parks that also offer hiking trails for example, was calculated by dividing the sum of column 6 (total number across States, of water-based State parks also offering hiking) by the sum of column 4 (total number, across States, of water-based State parks).

at pleasant landscapes. In the State site table, sightseeing is restricted to include only viewing an historic place or a truly unusual natural phenomenon. The Guides do not provide detailed enough information to expand this limited definition of sightseeing. Similarly, the "nature walks" category of activities from the Federal Estate Survey is different from the "nature program" category employed in collecting information from the Guides. The latter is defined to include marked nature walks, a trained naturalist on duty at the park, nature talks and presentations, and nature museums. The former probably includes some of these activities as well as unstructured, individual walks to observe and enjoy nature.

Table 5-15 reports, by State, average acreage of State parks and recreation areas and of all classes of State lands based on Federal recreation data.* With the exception of Wyoming, the average acreage of each State's parks and recreation areas is less than 10,000 acres.† State parks and recreation areas are generally smaller than the sample Corps recreation sites. Only six of the Corps sites are less than 10,000 acres in size, and the average acreage is 52,748.

5.6 SUBSTITUTION OPPORTUNITIES

The information summarized in the previous section can also be used to investigate the extent of substitution opportunities available to recreationists at Corps sites. The ideal method of identifying the relevant candidate substitutes

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*Although the Guides report acreage information for some State recreation areas, the data are not complete enough to calculate reliable average acreage figures by State. The Federal Recreation Fee Program report was chosen as a source because it reports, by category of State land, both total acreage and number of sites.

†Note that the data are for water-based and non-water-based sites combined.

Table 5-15. Average Acreage of State Parks and Recreation Areas and of All State Land

State	Average acreage, State parks and State rec. areas	Average acreage, all State land[a]	State	Average acreage, State parks and State rec. areas	Average acreage, all State land[a]
AL	2,088	2,088	NE	1,574	1,454
AZ	2,835	1,608	NV	9,401	7,560
AR	1,348	986	NH	1,659	1,402
CA	9,008	4,102	NJ	1,498	2,302
CO	NR	NR	NM	1,934	1,934
CT	345	866	NY	1,728	1,722
DE	889	889	NC	2,014[b]	3,091
FL	2,084	2,310	ND	903	773
GA	904	740	OH	2,611	2,611
ID	1,603	1,604	OK	1,523	1,251
IL	2,233	1,185	OR	400	400
IN	2,985	2,829	PA	2,619	2,328
IA	784	784	RI	NR	NR
KS	1,326	1,253	SC	1,280	1,174
KY	1,206	915	SD	2,749	1,429
LA	1,051	585	TN	2,536	1,250
ME	552	410	TX	1,841	1,250
MD	2,468	1,710	UT	3,519	1,579
MA	2,389[c]	1,710	VT	833	2,497
MI	2,785	2,598	VA	2,180	1,480
MN	2,278	2,055	WA	694	528
MS	770	770	WV	2,068	2,857
MO	2,261	1,455	WI	1,021	1,533
MT	NR	157	WY	13,545	2,366

[a] Includes State parks, forests, natural areas, recreation areas, historic areas, water use areas, environmental education areas, trails.

[b] Includes State forests.

[c] State recreation areas only.

SOURCE: U.S. Department of the interior. Federal Recreation Fee Report 1980. Washington, D.C.: Government Printing Office, 1980.

NR = not reported.

for a given Corps site is to ask recreationists at the site, as well as other individuals within the recreationists' zones of origin, what sites they consider to be substitutes for the Corps site. Unfortunately, this information was not gathered by the Federal Estate Survey. An alternative method is to search within the boundaries of concentric circles drawn about each Corps-site visitor's home. Since the Federal Estate Survey data include the zip codes of respondents, this exercise is possible, but impractical because of the large number of respondents. Instead, for the purpose of illustration, three Corps sites were chosen, each with the characteristic that the average distance traveled to the site was less than 70 miles. If most of the visitors to a Corps site live close to the site, the second-best method of identifying substitute sites may be approximated by checking the areas defined by concentric circles centered at the site.

Table 5-16 is a roster of candidate substitute State recreation areas for Grenada Lake, Mississippi; Youghiogheny River Lake, Pennsylvania; and Philpott Reservoir, Virginia. Mobil Travel Guide data are presented on acreage and activities available at water-based and nonwater-based* State recreation areas within 50 and 100 miles of each Corps site.

- Grenada Lake, MS

  Within 50 miles of Grenada Lake are three State recreation areas, all water based. Note that Hugh White State Park is situated on Grenada Lake. These three parks are much smaller than the Corps site on Grenada Lake; the largest of the three is 1,581 acres, compared to 86,826 acres for the Corps site. All three substitute sites, however, offer waterskiing, camping, and picnicking as does the Corps site. Also within 50 miles of Grenada Lake is Holly Springs National Forest. Nine other water-based State recreation areas in Mississippi, Tennessee,

*Nonwater-based sites may not be dismissed as substitutes for Corps sites, although water-based sites are likely to be perceived as better substitutes or perceived as substitutes by more recreationists.

Table 5-16. Potential Substitutes for Three Corps Sites

Area name	State	Land acre-age	Water acre-age	Activities: Motor boat-ing	Non-motor boat-ing	Fish-ing	Beach swim-ming	Water skiing	Camp-ing	Hik-ing	Pic-nick-ing	Golf	Ten-nis	Pool swim-ming	Bik-ing	Nature pro-gram	Sight-seeing	Rid-ing	Hunt-ing
Within 50 miles of Grenada Lake, MS																			
WATER BASED																			
John W. Kyle[a]	MS	740		√	√	√	√	√	√	•	√		√						
George Payne Cossar[b]	MS	900		√	√	√		√	√	√	√		√	√		√			
Hugh White[c]	MS	1,581		√	√	√		√	√		√			√					
Within 100 miles of Grenada Lake, MS																			
WATER BASED																			
Wall Doxey	MS	855		√	√	√	√		√	√	√					√			
Tombigbee	MS	702	102	√	√	√	√	√	√	√	√		√			√			
Lake Lowndes	MS	601	150	√	√		√	√	√	√			√			√			
Golden Memorial	MS	170		√	√	√			√	√	√					√			
Holmes County	MS	463		√	√	√	√		√	√						√			
Leroy Percy	MS	2,442		√	√	√			√	√	√			√		√			√
Meeman-Shelby Forest Day Use[d]	TN	12,500		√	√	√	√		√	√								√	
Lake Chicot	AR			√	√	√			√		√			√		√			
Village Creek[e]	AR			√		√			√	√	√					√			
NONWATER BASED																			
T. O. Fuller	TN	1,000				√			√		√	√		√					

[a]On Sardis Lake.

[b]On Enid Lake.

[c]On Grenada Lake.

[d]On Mississippi River and includes several lakes.

[e]Electric motors only.

Table 5-16 (continued)

Area name	State	Land acre-age	Water acre-age	Activities: Motor boat-ing	Non-motor boat-ing	Fish-ing	Beach swim-ming	Water skiing	Camp-ing	Hik-ing	Pic-nick-ing	Golf	Ten-nis	Pool swim-ming	Bik-ing	Nature pro-gram	Sight-seeing	Rid-ing	Hunt-ing
Within 50 miles of Youghiogheny River Lake, PA																			
WATER BASED																			
Ohiopyle	PA	18,719		✓	✓	✓			✓	✓	✓					✓			✓
Laurel Hill	PA	3,935		✓	✓	✓	✓		✓	✓	✓								✓
Shawnee	PA	3,840	450	✓	✓		✓		✓							✓			
Kooser	PA	170				✓	✓		✓	✓	✓								✓
Tygart Lake	WV	1,396		✓	✓	✓	✓		✓		✓								
Audra	WV	355				✓	✓		✓	✓	✓								
Deep Creek	MD	1,776		✓	✓	✓	✓		✓		✓								
Rocky Gap	MD		243	✓	✓	✓	✓		✓	✓	✓								
New Germany	MD		13	✓	✓	✓	✓		✓	✓						✓			
Herrington Manor	MD	365	53	✓	✓	✓	✓			✓	✓								
NONWATER BASED																			
Blue Knob	PA	6,000							✓					✓					
Pricketts Fort	WV	188		✓	✓						✓						✓		
Cathedral	WV	133								✓	✓								
Blackwater Falls	WV	1,688					✓		✓		✓		✓			✓			
Canaan Valley	WV	5,810				✓		✓			✓	✓	✓						
Coopers Rock[a]	WV	12,698				✓			✓	✓	✓								✓
Swallow Falls	MD					✓			✓		✓						✓		
Dans Mountain	MD	479				✓					✓								
Savage River Forest	MD	53,000				✓			✓	✓									✓
Garrett State Forest	MD	9,248				✓			✓	✓									✓
Potomac State Forest	MD	12,052				✓			✓	✓									✓
Green Ridge Forest	MD	25,559				✓			✓		✓								✓

[a] State Forest

(continued)

Table 5-16 (continues)

Area name	State	Land acre-age	Water acre-age	Motor boat-ing	Non-motor boat-ing	Fish-ing	Beach swim-ming	Water skiing	Camp-ing	Hik-ing	Pic-nick-ing	Golf	Ten-nis	Pool swim-ming	Bik-ing	Nature pro-gram	Sight-seeing	Rid-ing	Hunt-ing
Within 100 miles of Youhiogheny River Lake, PA																			
WATER BASED																			
Raccoon Creek	PA	7,224		√	√	√	√		√	√	√					√		√	√
McConnell's Mill	PA	2,512		√	√	√				√	√						√		√
Moraine	PA	15,838	3,225	√	√	√	√			√	√				√			√	√
Yellow Creek	PA	2,822		√	√	√	√			√	√								√
Black Moshannon	PA			√	√	√	√		√	√	√					√			√
Whipple Dam	PA	266		√	√	√	√				√								√
Prince Gallitzin	PA	6,249	1,600	√	√	√	√		√	√	√					√		√	√
Parker Dam	PA	895		√	√	√	√		√	√	√					√			√
Greenwood Furnace	PA	340				√	√		√	√	√					√	√		
Tomlinson Run	WV	1,399	27	√	√	√				√	√			√					
Cacapon	WV	6,155	6	√	√	√	√		√		√	√	√			√		√	
Seneca[a]	WV	11,686	4	√	√	√			√		√								√
Cunningham Falls	MD	4,985		√	√	√	√		√	√	√						√		
Fort Frederick	MD			√	√	√					√						√		
NONWATER BASED																			
Caledonia	PA	1,130				√			√	√	√	√		√	√				
S. B. Elliott	PA	330							√	√	√					√			√
Cook Forest	PA	6,422				√			√	√	√			√	√	√		√	√
North Bend	WV	1,402				√			√	√	√		√	√		√			
Cedar Creek	WV	2,167				√			√	√	√			√					
Holly River	WV	7,747				√			√		√		√	√		√			
Lost River	WV	3,680									√		√	√		√		√	
Berkeley Springs	WV													√			√		
Watters Smith	WV	530									√			√			√		
Kumbrabow[a]	WV	9,431				√			√	√	√								√
Gambrill	MD	1,136				√			√		√								

[a]State forest.

Table 5-16 (continued)

Area name	State	Land acre-age	Water acre-age	Motor boat-ing	Non-motor boat-ing	Fish-ing	Beach swim-ming	Water skiing	Camp-ing	Hik-ing	Pic-nick-ing	Golf	Ten-nis	Pool swim-ming	Bik-ing	Nature pro-gram	Sight-seeing	Rid-ing	Hunt-ing
				Activities															
Within 50 miles of Philpott Reservoir, VA																			
WATER BASED																			
Fairy Stone[a]	VA	4,570	168	√	√	√	√		√	√	√				√			√	
Clayton Lake	VA	472	5,000	√	√	√	√	√	√	√	√							√	
Hanging Rock	NC	5,022		√	√	√	√		√	√	√					√			
NONWATER BASED																			
Pilot Mountain[b]	NC	3,802			√				√	√	√					√		√	
Within 100 miles of Philpott Reservoir, VA																			
WATER BASED																			
Hungry Mother	VA	2,180	108	√	√	√	√		√	√	√							√	
Douthat	VA	4,493	70	√	√	√	√		√		√								
Holiday Lake	VA	250	150	√	√	√	√		√		√								√
Goodwin Lake-Prince Edward	VA	270		√	√	√	√		√	√	√								
Staunton River[c]	VA	1,287		√	√	√		√	√	√	√		√	√					
Occoneechee[c]	VA	2,690		√	√	√	√	√	√		√								
Duke Power[d]	NC	1,396		√	√	√	√		√	√	√					√			
Morrow Mountain[e]	NC	4,508		√	√	√			√	√	√					√	√	√	
Kerr Reservoir	NC		50,000	√	√	√	√	√	√		√								
Babcock	WV	3,637		√	√	√			√		√			√		√	√	√	
Bluestone	WV	2,145	1,800	√	√	√			√		√			√		√			
Watoga	WV	10,057	11	√	√	√			√		√		√	√		√		√	
Hawks Nest	WV			√	√	√				√	√		√	√			√		
NONWATER BASED																			
Mt. Jefferson	NC	539								√	√					√			
William B. Umstead	NC	3,954	55			√			√	√	√					√		√	
Grandview	WV	878								√	√								
Twin Falls	WV	3,776							√		√	√	√	√		√			
Droop Mtn. Battlefield	WV	288								√	√						√		
Cal Price[f]	WV	9,482				√													√
Pipesteam	WV	4,023				√			√			√	√	√	√	√		√	
Camp Creek	WV	5,897				√			√		√								√
Greenbrier[f]	WV	5,062				√			√	√	√			√		√			
Garnules Perry Battlefield[f]	WV	156								√	√						√		
[illegible]	WV	215									√						√		

[illegible]

[d]On Lake Norman
[e]On Lake Hillery

and Arkansas are within 100 miles of Grenada Lake. All are much smaller than the Grenada Lake Corps site, but all have camping and picnicking facilities available. Tombigbee, Bienville, Delta, and St. Francis National Forests are also within 100 miles of Grenada Lake.

Youghiogheny River Lake, PA

Within 50 miles of Youghiogheny River Lake are located 10 water-based and 12 nonwater-based State recreation areas. At least one of the State parks (Ohiopyle, PA) is substantially larger than the Youghiogheny River Lake Corps site. Camping, hiking and picnicking are available at many of the State recreation areas as well as at the Corps recreation site. However, there are no substitute tennis courts, biking or bridle trails at any of these water-based substitute sites. Fourteen additional water-based State recreation areas in Pennsylvania, West Virginia, and Maryland are located within 100 miles of Youghiogheny River Lake. At least six of these areas are larger than the Corps site. Eleven other nonwater-based State recreation areas are also within 100 miles of Youghiogheny River Lake. The Monongahela (WV) and George Washington (VA) National Forests and the Spruce Knob-Seneca Rock National Recreation Area are all within 100 miles of Youghiogheny River Lake as well.

Philpott Reservoir, VA

Three water-based, and one nonwater-based, State recreation areas are within 50 miles of Philpott Reservoir. One of the State parks (Fairy Stone) is on Philpott Reservoir. The largest of these three areas is just over half the size of the Corps Philpott site. However, every activity available at the Corps site is also available at at least one of the three substitute water-based recreation areas. Within 100 miles of Philpott and located in Virginia, North Carolina, and West Virginia are another 13 water-based State recreation areas. With the exception of biking, every activity available at the Corps site is also available at at least three of these alternate sites. Only one of the substitute sites--Watoga, WV--is larger than the Corps site. Within 50 miles of Philpott are Mount Rogers National Recreation Area (VA), and Jefferson National Forest (VA); within 100 miles are also Monongahela (VA), George Washington (VA), Uwharrie (NC), and Pisgah (NC) National Forests.

The descriptive appraisal of substitution opportunities at these three sites suggests the difficulties in trying to model recreation behavior without data on the recreationists' actual or perceived substitute sites. These three sites are ones that draw visitors, on average, from within an hour and a half drive, yet all have at least three sites within 50 miles and a substantially larger number within 100 miles. This implies that some caution is required in using the concentric circle approach to appraise substitution opportunities.

An alternative approach to the substitute site question is to elicit professional judgments on the availability of substitute recreation sites. This assessment was accomplished by asking Corps managers at the individual recreation sites for their judgments. Corps managers are aware of substitute sites and, in most cases, readily identified why such sites are attractive. About 60 percent of the managers consider that good substitutes to their own sites are available. Their assessment of a substitute site was usually based on its proximity to large metropolitan areas, the characteristics of its lake, and the types of activity permitted there. Again, this is a crude approximation because specific evaluation guidelines for degrees of substitutability were not established. It does not identify exactly how these substitutes affect the travel cost model for the site.

An important source of substitutes for the 43 sample sites are alternative Corps sites--ones not included in the Federal Estate Survey. This situation frequently arises because individual reservoirs are normally part of a system of reservoirs within a particular basin or navigation corridor. In most cases, alternate reservoirs are less than an hour's drive from the sample reservior. The Corps managers included these sites in their assessment of alternative sites.

Table 5-17 reports the Corps-assessed availability of substitute sites for reservoirs (dams without locks). Of the 36 sites, 21 have available substitutes The river pools behind dams with locks usually have good substitutes, because

Table 5-17. Availability of Substitutes for Sites Without Locks, Frequency by State

State	Substitutes available	Substitutes not available	Total
Arkansas	5 (13.9)	2 (5.6)	7 (19.4)
California	1 (2.8)	1 (2.8)	2 (5.6)
Kansas	3 (8.3)	0 (0)	3 (8.3)
Minnesota	3 (8.3)	0 (0)	3 (8.3)
Mississippi	2 (5.6)	1 (2.8)	3 (8.3)
Texas	4 (11.1)	5 (13.9)	9 (25.0)
All other States	3 (8.3)	6 (16.7)	9 (25.0)
Total	21 (58.3)	15 (41.7)	36 (100.0)

Source: Personal communication of RTI researchers with Corps personnel.

Notes: Figures in parentheses indicate percentages of the 36 sites that have dams but no locks. Rows and column percentages may not add to totals due to rounding.

these navigation systems are considered a continuous chain of separate recreation areas. The notable exceptions are Mississippi River Pool No. 6, Minnesota, and Lake Washington Ship Canal, which do not have good substitutes.

Various explanations account for the 15 sites that do not possess viable substitutes. Canton Lake, Oklahoma, and Rathbun Lake, Iowa, are located in areas that lack water-based recreation. In these regions, a large body of water is unique. Substitute sites are also not available when the reservoir is located within an urban area. Such sites, primarily day-use areas, are not comparable in facilities and activities to local parks. The resources available to these Corps sites easily overshadow the limited funding available to local parks. A majority of visitors used these sites for an afternoon only. Benbrook and Waco, Texas, are prime examples.

Several reservoirs offer attributes that provide exceptionally good conditions for activities not found at neighboring areas. These Corps sites also did not have good substitutes. For example, Millwood Lake, Arkansas, is popular for fishing because its many submerged trees create good fish habitats not found at sites within an 80-mile radius. Several lakes, such as Norfork Lake and Lake Ouachita, Arkansas, are popular for scuba diving because their water is deep and clear. The Lake Isabella, California, site includes a large amount of land dedicated to the preservation of riparian wildlife; and Dewey Lake, Kentucky, is extremely well developed for recreation.

Thus, the final attempt at gaining some insight into the effect of substitute sites for the 43 sample Corps sites involved eliciting the Corps managers' professional judgments about the degree of substitutability at the sites. Whether this variable, which admittedly is only a crude approximation, affects our model specifications is an empirical issue to be judged in the following chapters. What is clear is that omitting substitutes altogether is itself a less than satisfactory alternative. This omission would imply that the estimates are upwardly biased, but the extent of the bias is unknown. However, this Issue's importance has to be judged relative to the other strengths and weaknesses of the model and the data. These considerations are also developed in subsequent chapters.

5.7 SUMMARY

On the demand side, this chapter has compared the characteristics of the users of 43 Corps of Engineers sites with those of the general public and users of other Federal Estate lands. While these kinds of comparisons can be treacherous, our objective was to obtain a rough appraisal. Compared to the general public, users of the Corps of Engineers sites are more likely to be younger, Caucasian, and employed as craftsmen or foremen. They also are more likely to live in rural areas, have attained slightly higher levels of education, and earn higher incomes. In comparisons with users of other Federal Estate lands, users of the Corps of Engineers sites are less educated and less likely to be employed professionals or technical workers. They also earn lower incomes, are more likely to live in rural areas, and are more likely to have visited a site closer to their residences.

If one is interested in transferring the benefits from the model estimated with data on the Corps of Engineers recreationists to other recreationists, most of these differences are likely to have little effect. The users of Corps sites are fairly typical of a broad spectrum of the population. The least appropriate case for transferring the results would likely be one that draws users from some population with very unique features that would be expected to affect their recreation decisions. Otherwise, the data from users of Corps sites would seem representative.

On the supply side, this chapter has compared activities supported by the Corps of Engineers sites with those by other water-based sites on State and Federal Estate lands. Generally, all the sites support a broad range of activities with boating, fishing, swimming, picnicking, and camping the most popular. Differences seemed to be most prevalent in less popular activities like horseback riding. Limited data on site characteristics of non-Corps of Engineers sites precluded a supply side appraisal of site features.

On the assessment of substitution opportunities, the data limitations predominate the findings. Attempts to use the concentric circle method show the difficulties in trying to appraise the effected substitute sites on the travel cost demand model. Without data on observed visits to competing sites, the issue is moot. To supplement our database, correspondence with managers of the Corps of Engineers sites provided a qualitative or judgment-based measure of substitution potential for each of the sites. This correspondence indicated that a few of the Corps sites had virtually no close substitute, while the remaining have several sites the managers considered substitutes.